# THE INFLUENCE OF MATHEMATICS TEACHERS' KNOWLEDGE IN TECHNOLOGY, PEDAGOGY AND CONTENT (TPACK) ON THEIR TEACHING EFFECTIVENESS IN SAUDI PUBLIC SCHOOLS

By



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**DEDICATION**

*This work is dedicated*

*To the souls of my father and mother, May Allah have mercy on them.*

*To my beloved wife, Ghasbah Alshehri*

*To my wonderful children, Abdullah, Ziad and Lyan*

*To my brothers and sisters, Hatem, Saeed, Aisha, Shahrzad, Maha, Ahmad, Fatimah*

*Saleh, Rahaf and Mohammed*

## ABSTRACT

Many researchers including (Hill et al., 2008; McCray & Chen, 2012) have found that teachers' understanding of the mathematics content knowledge and their expertise in teaching methods "pedagogy" are largely responsible for how effective they are as teachers. More recent research (Lyublinskaya & Tournaki, 2012; Polly, 2011) suggests that teachers' ability to integrate technology into their teaching is also critical to their mathematics teaching effectiveness. This study investigated the validity of these assumptions for 7-12 grade mathematics teachers in Saudi Arabia and how their expertise in Technological Pedagogical And Content Knowledge (TPACK) influences their teaching effectiveness.

The central question for grade 7-12 Saudi Arabian mathematics teachers is: Does expertise in technology integration, pedagogy and content relate to teaching effectiveness? The TPACK expertise of 347 secondary male mathematics teachers in Riyadh public schools was measured by self-evaluation questionnaires. Principals from 109 schools rated their teachers by using a 14 item "Teacher Effectiveness" survey. Descriptive statistics, bivariate correlations, ANOVA, Paired-Samples t-test and MANOVA were used to evaluate the relationship between the teachers' TPACK knowledge and teaching effectiveness. Results showed that teachers evaluated their TPACK at a high level. On the TPACK 1-5 Likert scale survey (5 = highly competent), the teachers rated their general mathematics content knowledge (CK) at $M=3.7$ ($SD=.67$), their general pedagogy knowledge (PK) at $M=4.1$ ($SD=.55$), their general technology knowledge (TK) at $M=3.6$ ($SD=.70$), their pedagogical knowledge within mathematics content (PCK) at $M=4$ ($SD=.60$), their technological knowledge within mathematics

content (TCK) at M=3.7 (SD=.69), their technological knowledge within pedagogical knowledge (TPK) at M=3.6 (SD=.74), their technological pedagogical and content knowledge at M=3.7 (SD=.71), and their cumulative knowledge of technology, pedagogy and content at M=3.8 (SD=.52). The teachers also rated their professional preparation to integrate technology. They reported that their university courses prepared them to integrate digital technologies (M=3.51, SD=.88) better than professional development workshop and training (M=3.07, SD=1.7); $t(346)= 8.17$, $p<.01$. Principals rated the overall effectiveness of their teachers at M=3.11 (SD=.59) on the 14 item scale and their usage of technology at M=2.84 (SD=1.06).

Correlations between mathematics teachers' 7 TPACK self-efficacy and the principals' rating of teacher effectiveness were not significantly different. Negative correlations were found between principals' ratings of teaching effectiveness and the teachers' evaluation of their professional preparedness in university courses ($r=-.125$, $p<.05$) and professional development training programs ($r=-.129$, $p<.05$). This discrepancy may point to differences between the way these principals and the higher education institutions value teacher preparation curriculum. Further studies may consider comparing teachers' TPACK self-efficacy to student achievement.

بســم الله الـرحمـن الـرحيـم

## ملخص الرسالة

وجد الكثير من الباحثين ومنهم (هيل و أخرون، ٢٠٠٨ ؛ ماك كراي و تشن، ٢٠١٢) أن إلمام المعلمين بالمحتوى العلمي لمادة الرياضيات وإتقانهم لطرق التدريس يؤثر بشكل كبير على فاعلية تدريسهم. وحديثاً توصي الدراسات (لوبلنسكايا و تورناكي، ٢٠١٢؛ پالي، ٢٠١١) بأن مهارة المعلمين في استخدام التقنية الرقمية خلال التدريس أيضاً متطلب مهم لتحقيق تعليم فعال. هذة الدراسة تبحث في مصداقية هذة الافتراضات لمعلمي الرياضيات في المرحلتين المتوسطة و الثانوية في التعليم السعودي العام و كيفية تأثير معرفتهم بالمحتوى العلمي لمادة الرياضيات، و طرق التدريس، و استخدام التقنية الرقمية في التعليم على فاعلية تدريسيهم.

قام ثلاثمائة و سبعة و أربعون معلم رياضيات في مدينة الرياض بتقييم معرفتهم في مجالات المعرفة الثلاثة من خلال استبيان فيما تم تقييم فاعليتهم التدريسية من قبل مدراء المدراس التى يعملون بها. تم توظيف مجموعة من الاختبارات الإحصائية الوصفية و الارتباط الثنائي وتحليل التباين المتعدد (مانوڤا) واختبار العينتين الغير مستقلتين و تحليل التباين الثنائي (أنوڤا) لقياس العلاقة بين معرفة المعلم في المجالات الثلاثة (المحتوى، و طرق التدريس، و استخدام التقنية الرقمية) و فاعلية تدريسهم لمادة الرياضيات. أظهرت النتائج أن معلمي الرياضيات في مدارس التعليم العام بنين في مدينة الرياض للمرحلتين المتوسطة و الثانوية يتمتعون بثقة عالية في معرفتهم بنطاقات المعرفة الثلاثة (محتوى مادة الرياضيات، و طرائق التدريس، و استخدام التقنية الرقمية في التعليم) و المتعارف عليه باختصار الـ (تي باك). كما أن المعلمين أشاروا إلى رضاهم عن الإعداد الاكاديمي الذي حصلوا عليه خلال دارستهم الجامعية و أنه أعدهم لاستخدام التقنية بشكل فعال في تعليم الرياضيات، فيما عبروا عن ضعف التطوير التربوي المقدم لهم و عدم فاعليته في دعم استخدام التقنية الرقمية في تعليم الرياضيات. و لكن البيانات الإحصائية أشارت إلى عدم الإتفاق بين معلمي الرياضيات و مدراء المدارس حول التأثير الإيجابي لهذة المعرفة على تعليم الرياضيات. و ختاماً فإن المام معلمي الرياضيات و مدراء المدارس على حد سواء بأهمية اكتساب هذة المعرفة في مجالاتها الثلاث سوف يساعد على دعم فاعلية التدريس كما أنه يتفاعل بشكل ايجابي مع برامج إعداد و تدريب المعلمين.

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# CHAPTER I

# INDRODUCTION

Teaching the abstract topics of mathematics may not be easy since mathematics has unique and abstract linguistic features (vocabulary, syntax, semantic properties, discourse, and everyday language) (Capps & Pickreign, 1993; Carrasquillo & Rodriguez, 1996; Dale & Cuevas, 1987; Halliday, 1975, 1978; Pickreign & Capps, 2000). Students who have limited relational or conceptual mathematical understanding (Hiebert & Carpenter, 1992; Skemp, 1976) are more likely to have difficulty linking the five representational modes (concrete, pictorial, real-world situations, symbolic, and oral) (Niess & Mack, 2009; Pickreign & Capps, 2000), but a digitial technology, such as virtual manipulatives with their dynamic features, when effectively implemented in teaching mathematics, can promote the translation of mathematical concepts from one mode into another and support the dual coding of information (Izydorczak, 2003; Suh, Moyer, & Heo, 2005; Suh & Packenham-Moyer, 2007). In addition, digital technologies with dynamic representations (e.g., graphic calculators, calculator-based laboratories, mobile applications, virtual manipualtives, etc.) can provide mathematics learners with student-centered learning opportunities that are full of discovery learning and problem solving challenges but occur within safe, convenient, and contextualized situated environments (Bell, Juersivich, Hammond, & Bell, 2012). In general, digital technologies (e.g., computers, Internet, handheld devices, software, etc.) empower the learning environment and student experience by providing wide opportunities for *qualitative thinking* (Papert, 1993b), which is unstructured and leads students to explore and discover knowledge. Digital technologies are proven to be helpful instruction tools in directive and nondirective teaching models (Mitra & Dangwal, 2010; Papert, 1993a) and to enrich the Student-Centered Learning Environment (SCLE), which gives learners the opportunities to define their own needs for knowledge and skills and assign meanings to circumstances and contexts according to their prior knowledge and experiences (M. Liu, 2004; T. C. Liu, 2007; Lu, Ma, Turner, & Huang, 2007; Marupova, 2006; Papert, 1993a). Furthermore, digital technologies can support not only students' procedural or instrumental understanding (Skemp, 2006) through the variation in mathematical practices (e.g., drill and practice software) but also lead to conceptual or relational understanding by supporting the variation in solution strategies, representations, models, contexts, applications, and interactions (e.g., sketchpad, online discussion board, classroom clickers, spreadsheets, etc.) (Miller, 2012; Polly, 2011). Digital technologies can support effective scaffoldings for mathematics learners (Sharma & Hannafin, 2007) and accommodate the variations among their characteristics and their settings (Miller, 2012).

In addition to helping individual students increase their competency, digital technologies that are reliable, affordable, accessible, and usable can support equity in education when all students and teachers can have access to high quality educational resources (Meyen, Poggio, Seok, and Smith, 2006) and accommodate students' special needs, such as dyscalculia, in which students have a particular learning disability that inhibits learning and understanding mathematics, with a compensatory tool like a talking calculator (DO-IT, 2011). In teaching mathematics, this type of technology influences what curriculum should be taught, how it can be taught (National Council of Teachers of Mathematics [NCTM], 2000), and what knowledge and experience teachers need in order to teach mathematics with the implementation of technology (the Association of Mathematics Teacher Educators [AMTE], 2006).

Whether the influence of digital technologies on learning is classified either as a primary or secondary factor, it affects the speed and the quality of delivering instructions (Clark, 1994;

Kozma, 1991). In fact, two large mathematics professional organizations in the United States (National Council of Teachers of Mathematics [NCTM], 2000; the Association of Mathematics Teacher Educators [AMTE], 2006) recognize the integral role of digital technologies in increasing students' mathematical competence. Therefore, mathematics teachers today are expected to integrate effectively digital technologies in teaching (Grandgenett, 2008). The qualifications of this integration are addressed by the technological pedagogical content knowledge (TPACK) framework (AMTE, 2009; Mishra & Koehler, 2006), the synthesized product of the three areas of knowledge technology, pedagogy (teaching and student learning), and content (Mishra & Koehler, 2006; Niess, 2005). The quality of technology integration in teaching can be designed, developed, and evaluated with the TPACK framework (Bowers & Stephens, 2011; Chai, Koh, Tsai, & Tan, 2011; J. Harris, Grandgenett, & Hofer, 2010; Hofer, Grandgenett, Harris, & Swan, 2011; Hofer & Harris, 2010), and the teacher development stage of integrating technology can be identified by a TPACK development model before meeting the Mathematics Teacher TPACK Standards, which provide mathematics educators and researchers all the guidelines needed to effectively integrate digital technologies in learning and teaching mathematics (Niess et al., 2009).

**Statement of the Problem**

Designing and demonstrating an effective mathematics lesson requires teachers to acquire the merged knowledge of teaching and content (Shulman, 1986, 1987). This domain of knowledge has expanded to include technology since digital technologies have become more like thinking tools, not only instructional tools (Y.-J. Lee, 2010, 2011a, 2011b; National Research Council (U.S.) Committee on Information Technology Literacy, 1999; Papert, 1993b). Technological knowledge for educators has to encompass more than fluency with information technology; it must also include pedagogy and content knowledge. As a result, an emerging framework of technological pedagogical content knowledge came to describe how all three components of knowledge could be synthesized to teach a subject matter with digital technology effectively (Mishra & Koehler, 2006; Niess, 2005). Today, mathematics teachers in the field lack knowledge and skills in digital technologies, which correlates with limited experiences with effective integration of digital technology in mathematics education either during their primary or higher education (Niess, 2010a, 2012; Niess & Mack, 2009). According to the National Center for Education Statistics (Gray, Thomas, & Lewis, 2010), only 25 percent of elementary and secondary teachers in U.S. public schools reported that their undergraduate teacher program prepared them to integrate technology in their teaching effectively. This low technology self-efficacy might be attributed to their perceived unpreparedness to implement digital technologies that support constructivist learning environments (Aust, Newberry, O'Brien, & Thomas, 2005; Watson, 2006).

Saudi mathematics teachers are not unlike their American counterparts; in fact, many of them have never used digital technologies in their teaching or else they implement them with limitations either because they have no access to digital technologies (e.g., computer, Internet) in their classroom or because they received limited training in integrating technology into the teaching of mathematics (Al-Jarf, 2006; Alshumaim & Alhassan, 2010; Mullis, Martin, Foy, Olson, & International Association for the Evaluation of Educational, 2008; Oyaid, 2010). In addition, both prospective and in-service mathematics teachers reported a lack of training to implement digital technologies in teaching mathematics during their teacher educational programs and professional development programs (Albalawi, 2007; Albalawi & Ghaleb, 2011).

However, mathematics teacher preparation programs in Saudi Arabia do include courses about educational technologies and computer programming (e.g., College of Science (Imam University), 2011; The Deanship of Admission and Registration (KSU), 2011). As a result, and with the rapid growth and accessibility of these educational tools at schools through public education development projects (e.g., Watani, 2001; Tatweer, 2007), many important questions arise about mathematics teachers' readiness for teaching with digital technologies, such as:

- How knowledgeable are Saudi Arabian mathematics teachers in 1) technology integration, 2) teaching pedagogy, and 3) mathematics content?
- What is the relationship between teachers' self-perceived expertise in these domains and subdomains of knowledge (TK, CK, PK, PCK, TCK, TPK, TPACK; see pages 10-12 for definitions) and their teaching effectiveness?
- How active and effective, if it occurs, is their integration of digital technologies?
- What are teachers' perceived perceptions of their teacher education program and professional training and how do they relate to their self-perceived knowledge of mathematics content, teaching methods, and technology integration?

In addition, there is a growing concern about the effectiveness of the Saudi educational system, including mathematics teachers, after the failure of 79% of Saudi eighth graders to achieve the low international benchmark of mathematics achievement in the Trends in International Mathematics and Science Study (TIMSS) in 2007 (Mullis et al., 2008). This failure was associated with low level of teachers' preparation for teaching mathematics topics, a dearth of professional development programs, and lack of educational technology resources, including hardware, software, and technical support (Dodeen, Abdelfattah, Shumrani, & Hilal, 2012).

## Purpose of the Study

This study aims to investigate the relationship between mathematics teachers' self-perceived knowledge of technology, pedagogy, and mathematics content (TPACK) and principals' ratings of teacher effectiveness. Understanding such relationship is important to supporting the educational improvement strategies, enriching situated learning experience, and enhancing the seamless integration of digital technologies.

The main question that guides this study is: how does the expertise of 7-12 grade Saudi Arabian mathematics teachers in technology integration, teaching pedagogy, and mathematics content relate to their teaching effectiveness?

## Significance of the Study

Given the growing need for teacher education programs to equip future teachers with the knowledge and skills needed to achieve high quality technology integration, many criteria and standards for the qualification of such knowledge have developed. Unfortunately, some of these standards are either too broad or too narrow to align with the other important areas of knowledge content and pedagogy. Therefore, the recently adopted mathematics TPACK framework by AMTE is trying to shape the boundaries of this knowledge, considering all three areas of knowledge and providing educators and researchers with clear guidelines for establishing and evaluating an effective integration of digital technologies in teaching mathematics. However, research about the validation of such standards and assessment of the effectiveness of digital technologies integration on students' mathematics performance is limited.

In fact, mathematics TPACK research studies yielded a high percentage of the technology integration literature (Ronau et al., 2010); however, the influence of mathematics teachers' TPACK on their teaching effectiveness has been less robustly addressed (e.g., Buckner, 2011; Foley, Strayer, & Regan, 2010; Lyublinskaya & Tournaki, 2012; Ronau & Rakes, 2012b). This study afforded a descriptive overview of the current scope regarding the relationship between secondary mathematics teacher TPACK and teacher effectiveness. It allowed for insights into how well prepared mathematics educators feel to integrate digital technologies and into the factors that may hinder or facilitate this preparedness. In addition, it captured a collection of new understandings about both the supportive conditions Saudi mathematics teachers' needs and the struggles they face as they fully develop their TPACK in public school.

The finding of this study may enrich the theoretical knowledge about mathematics TPACK, provide considerable ideas and suggestions for developing in-service mathematics teachers' TPACK, and help educational policymakers and planners in the reformulation and improvement of strategies to attain successful implementation of digital technologies in teaching mathematics. Second, it may help in examining the quality of the mathematics teacher and professional training programs in equipping teachers with all the desired technological pedagogical content knowledge (TPACK) in order to have a seamless and effective integration of digital technology into the teaching of mathematics. Third, with the fast growing interest in building a framework to effectively integrate digital technology in learning and teaching mathematics, this study may facilitate the growth of communities devoted to mathematics TPACK and how improve this framework can be applied and evaluated.

**Research Questions**

The questions developed for the study focus on teachers' self-perceived expertise in technology, pedagogy, and content areas of knowledge (TPACK) and its relationship to teacher effectiveness.

Research Question 1: What is the self-perceived expertise of 7-12 grade Saudi Arabian mathematics teachers in 1) technology, 2) teaching pedagogy, and 3) mathematics content, including the combinations of these domains?

Research Question 2: Is there a significant linear relationship between teacher effectiveness and mathematics teachers' self-perceived knowledge in technology, pedagogy, and mathematics content and the intersections between them?

Research Question 3: What is the perceived preparation level of Saudi Arabian 7-12 grade mathematics teachers in integrating digital technologies in their teaching?

Research Question 4: Is there a significant linear relationship between teacher effectiveness and preparation level in integrating digital technologies in teaching mathematics?

Research Question 5: Is there a significant linear relationship between the perceived knowledge and preparation level of Saudi Arabian 7-12 mathematics teachers with respect to digital technologies integration?

Research Question 6: Is there a significant relationship between mathematics teachers' demographic variables (age, level of education, number of teaching grade level, classroom size, major, school of graduation, teachers' aptitude test scores, years of teaching mathematics, years of teaching other subject matter, and teaching experience) and their teaching effectiveness?

Research Question 7: Is there a significant relationship between mathematics teachers' ratings of their level of anxiety with teaching mathematics and their teaching effectiveness?

Research Question 8: Is there a significant relationship between mathematics teachers' ratings of their level of anxiety with integrating technology in their teaching and their teaching effectiveness?

**Research Hypotheses**

There are eight directional and nondirectional correlational research hypotheses for this study. These research hypotheses will correspond to the above research questions:

H1. Saudi Arabian 7-12 mathematics teachers rate themselves high on their knowledge of technology, pedagogy, and mathematics content and the intersections between these three domains of knowledge.

H2. There is a statistically significant linear relationship between mathematics teachers' self-perceived knowledge in technology, pedagogy, and mathematics content and their teaching effectiveness.

H3. Saudi Arabian 7-12 mathematics teachers rate their level of preparation as high in integrating digital technologies in teaching mathematics.

H4. There is a statistically significant linear relationship between teacher effectiveness and preparation level of integrating digital technologies in teaching mathematics.

H5. There is a statistically significant linear relationship between the perceived knowledge and preparation level of Saudi Arabian 7-12 mathematics teachers with respect to digital technologies integration.

H6. There is a statistically significant relationship between mathematics teachers' demographic variables (age, level of education, number of teaching grade level, classroom size, major, school of graduation, teachers' aptitude test scores, years of teaching mathematics, years of teaching other subject matter, and teaching experience) and their teaching effectiveness.

H7. There is a statistically significant relationship between the level of anxiety with teaching mathematics and teacher effectiveness.

H8. There is a statistically significant relationship between the level of anxiety with teaching with technology and teacher effectiveness.

**Definitions of Terms**

**Digital Technologies:** all educational hardware and software educators can use to design, apply, and evaluate their instruction (e.g., computers, Internet, calculators, etc.).

**TPACK framework:** the synthesized product of the three areas of knowledge technology, pedagogy (teaching and student learning), and content (Mishra & Koehler, 2006).

**TPACK Developmental Levels:** the teachers' five levels of technology adaption model (recognizing, accepting, adapting, exploring, and advancing) that describe the stage of development teachers have approached toward the effective integration of digital technologies (Niess, 2012).

**Mathematics TPACK Standards:** an extended framework for the work of Niess (2005), Mishra and Koehler (2006), and the National Educational Technology Standards for Teachers (ISTE 2009) focusing on mathematics education and providing guidelines about the technological pedagogical mathematics knowledge needed for teachers to accomplish high quality integration of technology in teaching mathematics (AMTE, 2009; Niess et al., 2009).

**Teacher Effectiveness (TE):** teacher's abilities to advance students' learning opportunities and meet their diverse needs within various learning environments.

**Content Knowledge or Subject Matter Knowledge (CK):** the expertise in the subject matter of mathematics, which entails acquiring *common content knowledge* (CCK) (Shulman, 1986) and *specialized content knowledge* (SCK) (Ball, Thames, & Phelps, 2008).

**Common Content Knowledge (CCK):** the general mathematical knowledge needed across all mathematics-related professions or occupations (Hill, Ball, & Schilling, 2008).

**Specialized Content Knowledge (SCK):** the specific mathematical knowledge that is needed for teaching mathematics (Ball et al., 2008).

**Horizon Content Knowledge (HCK):** the broad range of mathematical content understanding that enables teachers to make connection between mathematics topics in a curriculum (Ball et al., 2008).

**Knowledge of Content and Students (KCS):** the combined knowledge of mathematical content and students' learning process (Ball et al., 2008).

**Knowledge of Content and Teaching (KCT):** the combined knowledge of teaching and mathematics content (Ball et al., 2008).

**Pedagogical Knowledge (PK):** the knowledge of methods and strategies of teaching and learning, including the ability to design, implement, and evaluate instructions that respond to students' needs.

**Pedagogical Content Knowledge (PCK):** the unique understanding of subject matter that allows teacher to design, apply, and evaluate the appropriate instructional strategies and representations for particular topics that meet students' needs (Grossman, 1989, 1991; Shulman, 1986, 1987). This domain of knowledge includes knowledge of content and students (KCS) and knowledge of content and teaching (KCT).

**Mathematical Knowledge for Teaching (MKT):** the mathematical knowledge required to teach mathematics (Ball et al., 2008). This domain encompasses the pedagogical content knowledge (PCK) and the two levels of content knowledge (CK): Common Content Knowledge (CCK) and Specialized Content Knowledge (SCK).

**Technology Knowledge (TK):** the conceptual and practical understanding of information technology and how it can be applied correspondingly to various contexts (J. Harris, Mishra, & Koehler, 2009).

**Technology Content Knowledge (TCK):** the understanding for the reciprocal relationship between technology and content in matter of affordances and constraints (J. Harris et al., 2009). A mathematics teacher who has a high level of TCK would integrate the technology tool that best represents his or her own mathematics topic.

**Technology Pedagogy Knowledge (TPK):** the understanding of the reciprocal relationship between technology and pedagogy (teaching and learning) in matter of affordances, and constraints (J. Harris et al., 2009). For example, some teaching methods (e.g., collaborative teaching and learning, mathematics discourse) are enhanced by the integration of digital technologies like Wiki, WebQuest, Skype, and other communication and social networking programs; however, one of them can be better than the others based on its affordances and constraints toward the selected teaching strategy.

## Summary

This chapter established the framework for this study and provided an overview of the structural development of technological pedagogical content knowledge and its relationship with mathematics instruction. It includes the statement of the problem, research questions, the significance of the study, and definitions of terms.

# CHAPTER II

# LITERATURE REVIEW

This research study examined the influence of mathematics teachers' self-perceived knowledge in technology, pedagogy, and content (TPACK) on their teaching effectiveness. Therefore, this chapter provides a review of the literature that explains the importance of technology, pedagogy, and mathematics content knowledge (TPACK) for mathematics teachers to master in order to be effective. Definition, characteristics, and evaluation of teaching quality are discussed in the first section. The second section covers the history and the theoretical background of technological pedagogical content knowledge (TPACK). It also includes assessment tools for evaluating TPACK and its implementations in mathematics education.

A literature search procedure was followed for this study to carry out a comprehensive overview of a wide range of teacher's TPACK and teaching effectiveness researches. Research Databases such as PsychINFO, Education Resources Information Center (ERIC), ProQuest Dissertations & Theses (PQDT), ProQuest Research Library, Educator's Reference Complete, Expanded Academic ASAP, Wilson OmniFile Full text select, Academic Search Premier, JSTOR, SpringerLink, Web of Knowledge, SAGE journals, ScienceDirect, Education & Information Technology Digital Library (EdITLib), Google Scholar, and the University of Kansas Library's Catalog were searched. Manuscripts in these databases were selected based upon two criteria: (1) examination of the effect of teachers' knowledge on their teaching effectiveness and (2) evaluation of the importance for mathematics teacher s' acquisition of the technological pedagogical content knowledge (TPACK). The database search applied the following keywords individually or in combination: "technological pedagogical content knowledge," "TPACK," "TPCK," "teacher knowledge," "teacher OR teaching effectiveness," "teacher OR teaching quality," "student achievement," "teaching performance," "mathematics," "technology," and "education."

**Teacher Effectiveness**

Teaching as an art or a science (Eisner, 2002; Lindley, 1970; Makedon, 1990) necessitates learning to occur in order to be effective. Teachers have an integral role on how, what, and how much students learn and influence students' level of interactions with curriculum, peers, and the environment (Darling-Hammond, 1997; Stronge, 2007). Teacher effectiveness is even estimated to be the major factor on student achievement (Aaronson, Barrow, & Sander, 2003, 2007; Brophy & Good, 1984; Clotfelter, Ladd, & Vigdor, 2007; Darling-Hammond & Youngs, 2002; Drury & Doran, 2003; Greenberg, Rhodes, Ye, & Stancavage, 2004; Greenwald, Hedges, & Laine, 1996; Hanushek, 1971; D. Harris & Sass, 2006; Hershberg, Simon, & Lea-Kruger, 2004; Nye, Konstantopoulos, & Hedges, 2004; Rivkin, Hanushek, & Kain, 2005; Rockoff, 2003; Sanders & Horn, 1998; Sanders & Rivers, 1996; The Teaching Commisssion, 2004; Wayne & Youngs, 2003), in opposition to the earlier findings of research reports, like the Coleman report ([1966], also called *Equality of Educational Opportunity* study) and Plowden study (Peaker, 1971), which concluded that the influence of teaching quality on students' success was not unlike other school resources. As a result, teacher quality is a significant predicator of student achievement (e.g. mathematics) in many nations (Akiba, LeTendre, & Scribner, 2007) and an essential benchmark in any reform to the educational system (U.S. Department of Education, 2010). However, this role of influence on students and their learning process occurs through various characteristics that might be either personal or professional, and there is no agreement on which characteristics are more effective or how they can be evaluated (Stronge, 2007). In fact, the difference in measuring teachers' effectiveness is related to the difference in defining the meaning of teaching quality (Eisner, 2002). Eisner (2002) defined two standards for evaluating the quality of teaching that are based either on the quality of students' achievement or the quality of teaching performance, illustrating the challenging of measuring teaching quality. Finally, whether the teacher as an instructor and the main source of knowledge (as he is viewed in behaviorism and positivism) or as a facilitator and the main source of guidelines (as he is viewed in constructivism and constructionism), the teacher is still held accountable for student achievement by administrators, parents, and policymakers at various levels.

**Definition.** Teacher effectiveness or quality (Anfara & Schmid, 2007; Darling−Hammond & Rustique−Forrester, 2005; Torff & Sessions, 2005) has been defined in many different ways with many different criteria or indicators (Goe, 2007; National Research Council (U.S.) Committee on Assessment and Teacher Quality & Mitchell, 2001; Schrag, 2003; Strong, 2011; Stronge, 2007), although it is very important to have a unique and clear definition for any educational policy and reform. Despite the variety in definition, the effectiveness of any teacher quality characteristic is usually measured by its impact on student achievement more than on teaching performance. In addition, teacher effectiveness is present in every educational policy and has been researched by educators for decades; however, no agreement has been reached about its characteristics (Goe, 2007) and no conclusive definition has been established for its elements (Schrag, 2003). The disagreement among researchers and educators about the definition of teacher quality or effectiveness led to another about the evaluation of teacher quality. Therefore, common measureable characteristics of teacher quality such as certification (Darling-Hammond, Berry, & Thoreson, 2001; Rice, 2003; Wilson & Floden, 2003), level of education (Betts, Zau, & Rice, 2003; Goldhaber & Brewer, 1997), major (Goldhaber & Brewer, 2000; Rowan, Chiang, & Miller, 1997; Wenglinsky, 2000; Harold Wenglinsky, 2002), and teaching experience (Cavalluzzo, 2004; Clotfelter, Ladd, & Vigdor, 2005; Darling-Hammond, 2000; Murnane & Phillips, 1981; Rowan, Correnti, & Miller, 2002) have been used by researchers as proxies or indicators for effective teachers. However, other researchers considered such characteristics as prerequisites for high quality teaching (Stronge, 2007). Stronge (2007) claimed that a teacher's personality and teaching ethics, classroom management skills, preparation and execution of instruction and assessment, and evaluation of student learning progress are more important indicators of effective teachers than any other criterion. Other researchers considered content, pedagogy, and pedagogical content knowledge (Ball et al., 2008; Delaney, Ball, Hill, Schilling, & Zopf, 2008; Grossman, 1990b; Hill & Ball, 2004; Hill, Blunk, et al., 2008; Hill, Rowan, & Ball, 2005; Rowan et al., 1997; Shulman, 1986; Strong, 2011; Stronge, 2007) as fundamental requirements for effective teaching. Furthermore, the category of knowledge has been enlarged to include digital technologies in response to its rapidly growing role in education; thus teachers need to acquire the technological pedagogical content knowledge in order to be effective (Grandgenett, 2008; Mishra & Koehler, 2006; Niess et al., 2009). As a result of multiple dimensions of knowledge, teachers need to recognize the context of teaching and other external variables such as environment and how their knowledge interacts with all of them (Ronau & Rakes, 2012a; Ronau et al., 2010)

In summary, this controversy about the definition of teacher quality or teacher effectiveness can be tied to differences related to philosophies and measurability around teaching performance and its relationship with student achievement.

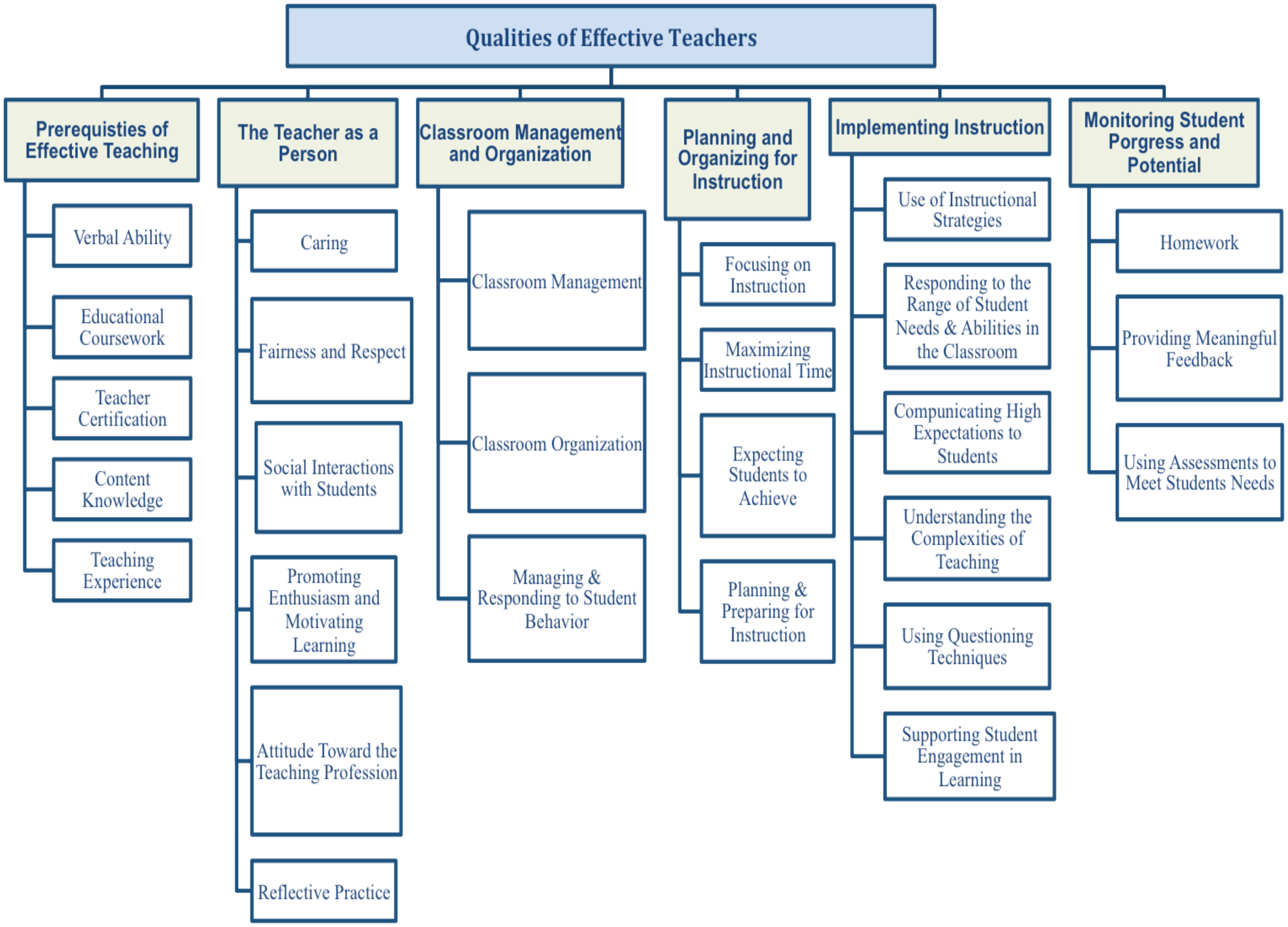
**Characteristics of effectiveness.** Researchers are, broadly, in agreement that having a positive influence on students is a characteristic of high quality teaching. However, many qualities of effective teaching are not agreed upon by researchers, educators, parents, and policymakers (Brown, Morehead, & Smith, 2008). Some characteristics are theoretically and/or practically supported. For example, knowledge of the content is taken as the primary qualification for any person to teach that content (Hill et al., 2005; Shulman, 1987). Although the proficiency level of such knowledge may differ from one case to another, it is a prequalification for the profession of teaching. In addition, knowing how to teach is also critical and axiomatic for effective teaching (Darling-Hammond, 2005; Grossman, 1989; Shulman, 1986; Stronge & Hindman, 2006), and some researchers go further and claim that pedagogy knowledge is more important than content knowledge (Blanton, Sindelar, & Correa, 2006; Torff & Sessions, 2005). However, both knowledge domains and their interactions in subdomains are equally important for mathematics teachers to comprehend (Shulman, 1987; Stronge, 2007). In addition, some characteristics are measureable or visible, and some are not or are hard to measure (Fenstermacher & Richardson, 2005; Polk, 2006). For instance, personal attributes such as motivation and attitudes are hard to evaluate, whereas major or educational level can easily be measured with one simple question (Strong, 2011). Furthermore, among measureable teacher effectiveness indicators, some can be measured in one set of questions and others need to be measured over a period of time. For example, technology integration in teaching mathematics requires more than one classroom observation evaluation; however, content knowledge can be measured by an aptitude test in one set of observations. Some qualities of effective teachers are knowledge, abilities, and cognitive skills (Hill, Blunk, et al., 2008; Stronge, 2007), and others are morals, dispositions, and teaching ethics (Arroyo, Rhoad, & Drew, 1999; Corbett & Wilson, 2002). Some characteristics are internal or personal qualities, and others are external or social qualities. For instance, having patience and wide interests are important personal qualities for teachers (Strong, 2011; Stronge, 2007) as well as is having active and positive interactions with students, environment, peers, and administrators (Berry, 2001; Darling-Hammond, 2005). Some teaching characteristics can be evaluated only by a single method of evaluation, but others can be evaluated by various approaches (Strong, 2011). Knowledge of mathematics, for example, can be evaluated with different measurement methods (e.g., standardized test, classroom observation); in contrast, psychological attributes such as honesty, integrity, commitment, enthusiasm, positive self-esteem, personal presentation, motivation, etc. can only be measured by a subjective method.

As a result of having wide range of teacher characteristics as measures of effectiveness, researchers and educational agencies in different U.S. states grouped them in categories (Bersin & Sandy, 2007; Chester & Zelman, 2007). Stronge (2007) arranged them in six domains: prerequisite features and skills, teacher's personality features, classroom management and organization skills, instructional design skills, instructional application skills, and educational assessment and evaluation skills (see Figure 1). However, Strong (2011) placed them in four groups: competences, personal attributes, pedagogical skills and practices, and teacher effectiveness. Once again, this is another indication of the complexity of teacher education and evaluation that mathematics educators and researchers have to address.

In the following section, the knowledge domains of digital technologies, pedagogy, mathematics content, and their interacting subdomains will be explained as effective teacher qualities since they are the focus of the study.

Figure 1

*Stronge's (2007) Six Categories of Teacher Effectiveness Characteristics*



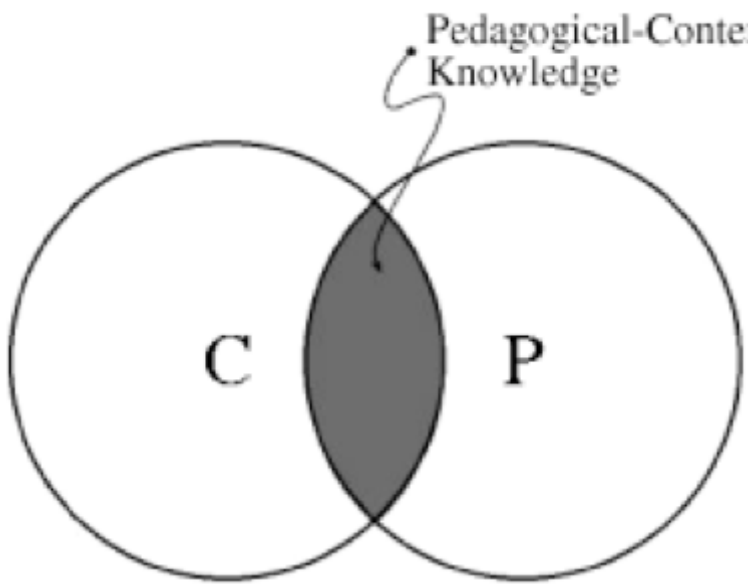

## Teacher Knowledge

Several areas of knowledge mathematics teacher are required or recommended to master. Subject matter knowledge (CK) and pedagogy knowledge (PK) are considered to be the foundation for effective teaching (Grossman, 1989, 1991; Shulman, 1986, 1987). First, knowledge of mathematics (CK) is theorized to have three subdomains: *common content knowledge* (CCK), *specialized content knowledge* (SCK) and *horizon content knowledge* (SCK) (Ball et al., 2008). Ball, Thames, and Phelps (2008) defined the common content knowledge as the general mathematical knowledge that is needed across all mathematics-related professions or occupations, and they described the specialized content knowledge as the specific mathematical knowledge that is needed for teaching mathematics. In addition, they explained the horizon content knowledge as the broad range of mathematical content understanding that enables teachers to make connection between mathematics topics in a curriculum. Second, pedagogy knowledge (PK) completes the picture of effective teaching practices; it is defined as the knowledge of methods and strategies of teaching and learning, including the ability to design, implement, and evaluate instructions that respond to students' needs (Grossman, 1989, 1991; Shulman, 1986, 1987). Third, researchers speculated that effective teachers, in addition to skillfully navigating the intersection of content and pedagogy knowledge, advance student achievement via the unique understanding of subject matter that allows teachers to design, apply, and evaluate the appropriate instructional strategies and representations for particular topics that meet students' needs (Grossman, 1989, 1991; Shulman, 1986, 1987). This pedagogical content knowledge (PCK) includes knowledge of content and students (KCS) and knowledge of content and teaching (KCT) (see Figure 2). The knowledge of content and students (KCS) is the combined knowledge of mathematical content and students' learning process, and the knowledge of content and teaching (KCT) is the combined knowledge of teaching and mathematics content (Ball et al., 2008). Furthermore, the development of teachers' PCK can be evaluated by Grossman's (1989, 1991) four criteria:

1. The teacher has a comprehensive understanding of the purpose of teaching a certain subject matter.
2. The teacher has knowledge of instructional strategies and knows how to present particular topics.
3. The teacher has knowledge of students' understanding and misconceptions of the subject matter.
4. The teacher has knowledge of curriculum and curricular materials regarding subject matter.

Figure 2

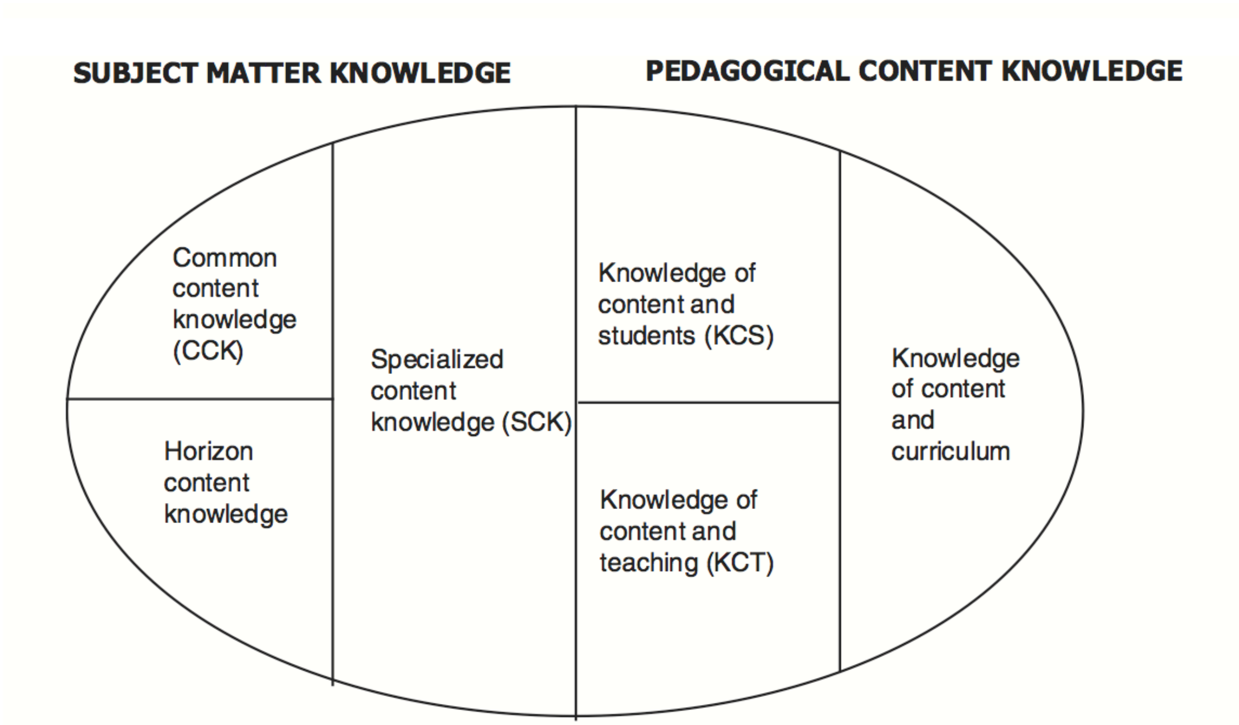
*Shulman's Model of Pedagogical Content Knowledge (PCK) (Mishra & Koehler, 2006, p.1022)*




Ball and her colleagues (2008) theorized that mathematics teaching effectiveness entails also the mathematical knowledge for teaching (MKT), which is more comprehensive than the pedagogical content knowledge (PCK). They described it as including the two traditional domains of pedagogical content knowledge (knowledge of content and students (KCS) and knowledge of content and teaching (KCT)), and content knowledge with its common content knowledge (CCK) and specialized content knowledge (SCK) (Ball et al., 2008) (see Figure 3).

Figure 3

*Mathematical Knowledge for Teaching (Ball et al., 2008, p.403)*

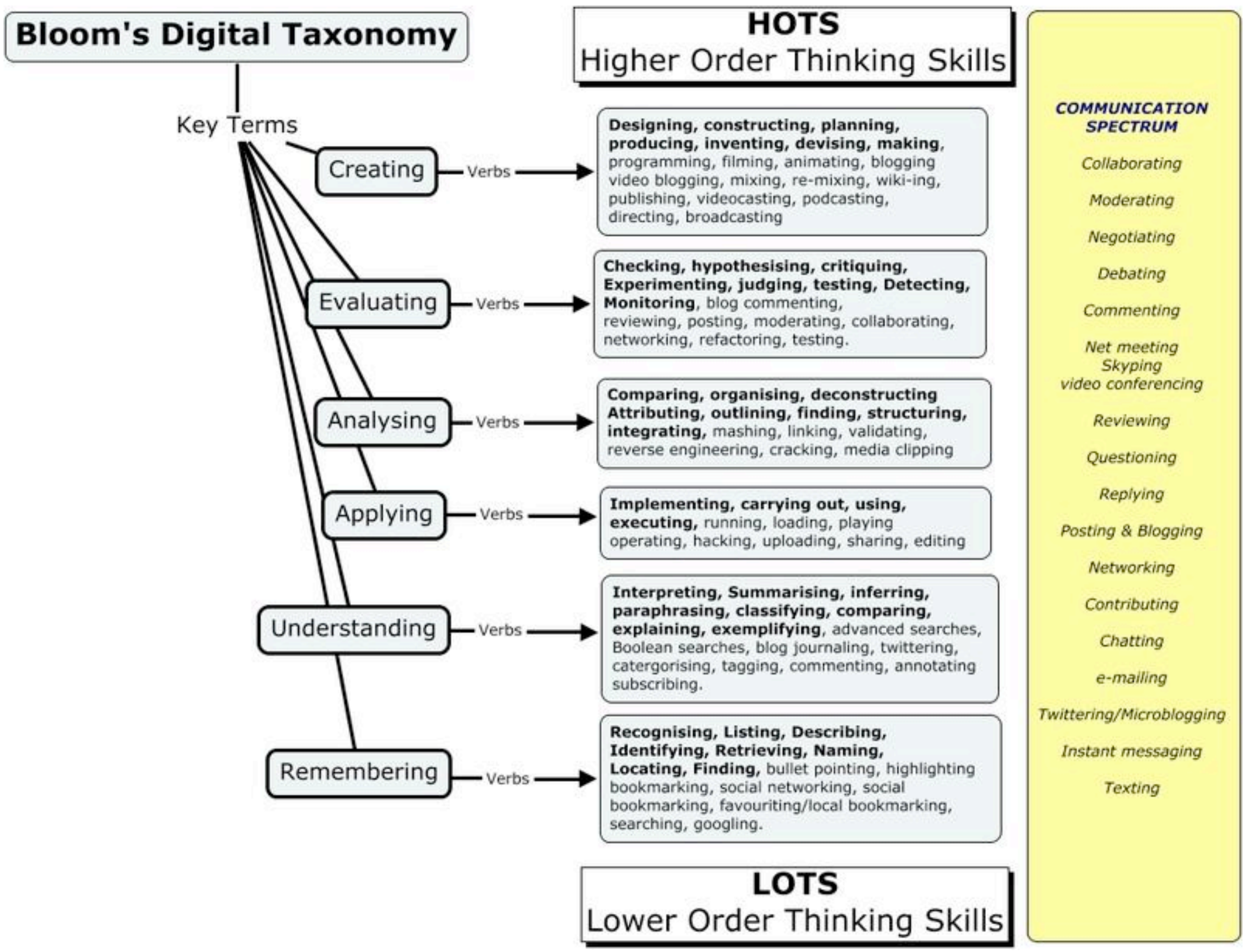



Recently, in response to its growing critical role in education, knowledge of digital technologies has been added as a required knowledge domain for integrating digital technologies in teaching. Mathematics and technology as subject areas have a strong interrelationship, and digital technologies offer mathematics learners dynamic representations for abstract mathematical concepts. Digital technologies not only support the conceptual and procedural understanding of mathematics but also help connect these types of understanding. Furthermore, the learning process is facilitated and enhanced by digital technologies through leveraging Lower Order Thinking Skills (LOTS) and Higher Order Thinking Skills (HOTS) with new digital cognitive objectives that are presented and explained in the innovation of Bloom's Digital

Taxonomy (see Figure 4) (Churches, 2009). Knowing how to use digital technologies qualifies mathematics teachers to help their students accomplish these digital cognitive objectives.

Figure 4

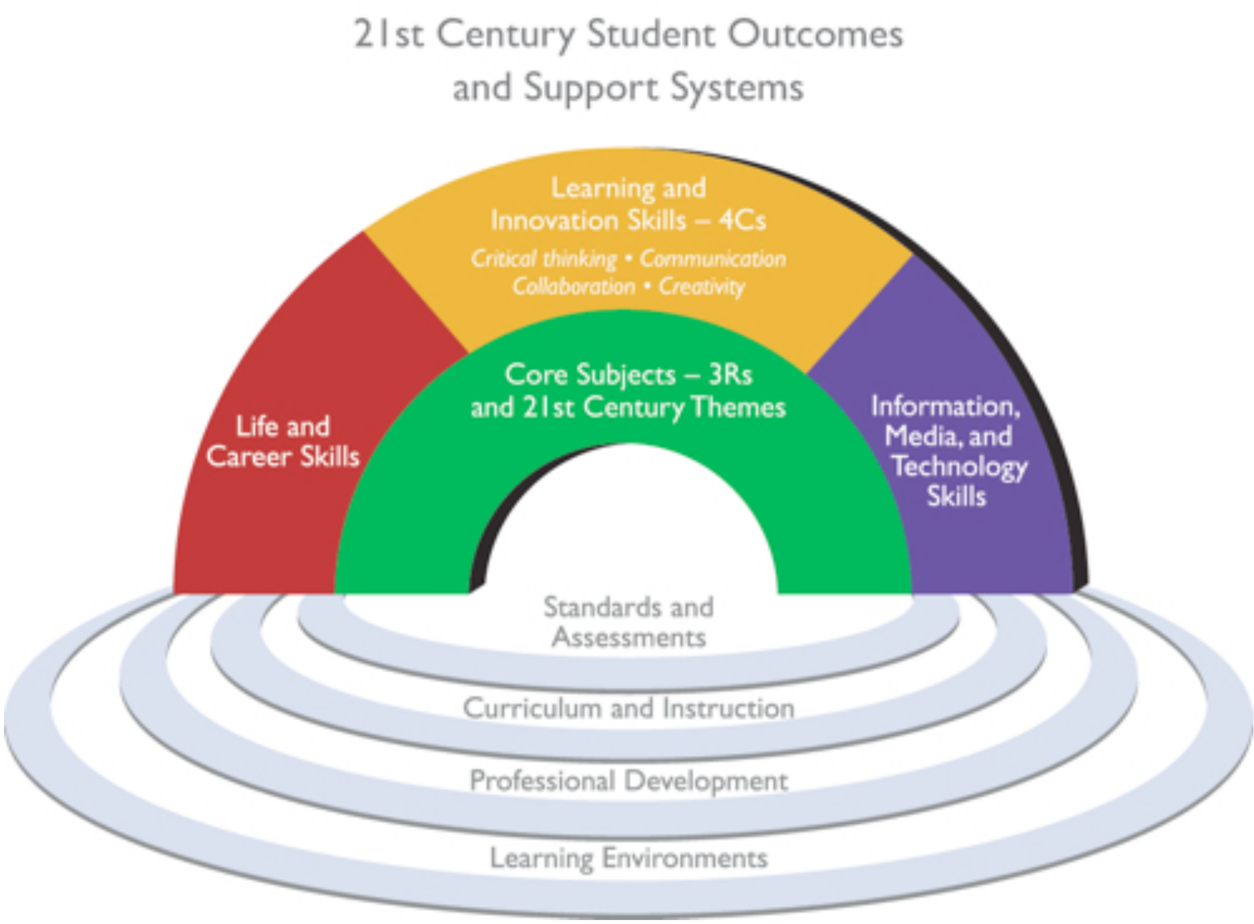
*Bloom's Digital Taxonomy (source: http://edorigami.wikispaces.com/Bloom's+Digital+Taxonomy)*




In addition, the affordance of video podcasting technology (e.g., Khan Academy) can digitize teaching methods with new approaches such as "Flip Teaching" or "Flipping the Classroom" (J. W. Baker, 2000) that offer more genuine opportunities for "4Cs" (critical thinking, communication, creativity, and collaboration) (see Figure 5) (Partnership for 21st Century Skills, 2003) than do traditional teaching strategies. In fact, collaboration is even considered more important for the 21st century skills than it has been in the past; therefore, Churches (2009) included it as an additional element in his Bloom's Digital Taxonomy. This interaction between digital technologies and teaching methods indicates that teacher knowledge of digital technologies has to be more than just knowing how to operate them.

Figure 5

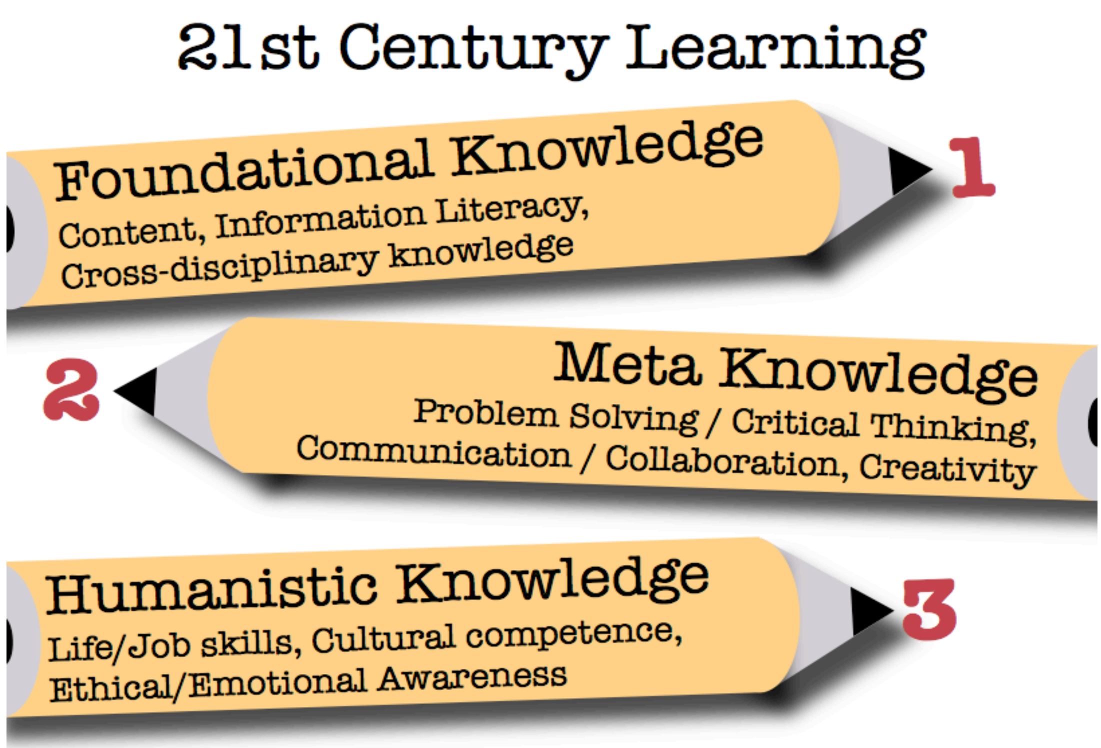
*21st Century Learning Skills (source: http://www.p21.org/overview)*




In fact, the 21st Century Learning Skills idea, a framework of skills, knowledge and expertise seen by educators as necessary for students to master to succeed in work and life, has received increased attention and criticism with the growing role of digital technologies in education (Boling & Beatty, 2012). Twenty-first century learning is defined in different and common ways, but Mishra and Kereluik (2011) synthesized ten major educational frameworks of the concept in three categories 1) Foundational Knowledge, which includes Content, Information Literacy, and Cross-disciplinary Knowledge; 2) Meta Knowledge, which includes Problem Solving/Critical Thinking, Communication/Collaboration, and Creativity; and 3) Humanistic Knowledge, which includes Life/Job Skills, Cultural Competence, and Ethical/Emotional Awareness (see Figure 6). However, Mishra and Kereluik (2011) argued that Information Literacy and Cultural Competence and Awareness are the only skills that can be claimed to be 21th century learning skills. This change in learning objectives as a consequence for the growing role of digital technologies has increase the demand for mathematics teachers to know how to teach with digital technologies.

Figure 6

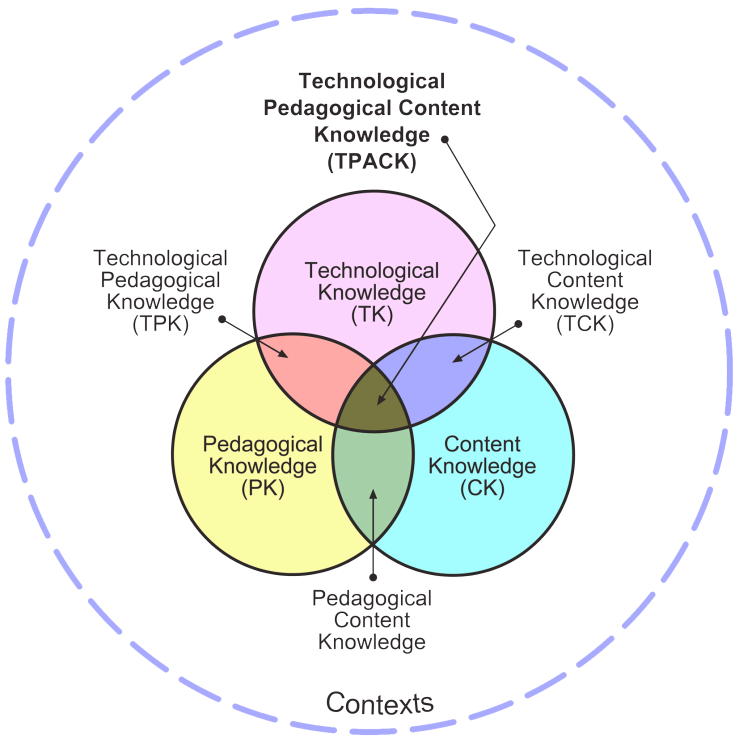
*Three Categories of 21$^{st}$ Century Learning Skills (source: http://punya.educ.msu.edu/presentations/site2011/SITE_2011_21st_Century.pdf)*



Digitizing or technologizing learning and teaching are combined with digitized curriculum and environment, and this emphasizes once again the importance for teachers to have a comprehensive understanding of using digital technologies into teaching. Technology knowledge (TK) is the understanding of how to use technology in general, but teachers need to know how to teach effectively their mathematics topic to their unique group of students with the integration of digital technologies (Mishra & Koehler, 2006; Niess, Kajder, & Lee, 2008), which is the technological pedagogical content knowledge (TPACK). This knowledge is the product of synthesizing the subject matter, pedagogy, and digital technologies domains of knowledge and then utilizing this synthesis to identify the affordances and constraints of digital technologies to teach a subject matter (see Figure 6) (J. Harris et al., 2009; Koehler & Mishra, 2009; Mishra & Koehler, 2006; Niess, 2005). It also can be defined as the further acquisition of technological content knowledge (TCK) or technological pedagogical knowledge (TPK). Technology content knowledge (TCK) is described as the understanding of the reciprocal relationship between technology and content in matter of affordances and constraints (J. Harris et al., 2009). Consequently, a mathematics teacher would integrate the technology tool that best represents his or her own mathematics topic. The technology pedagogy knowledge (TPK) is illustrated as the understanding of the reciprocal relationship between technology and pedagogy (teaching and learning) in matter of affordances and constraints (J. Harris et al., 2009). For example, some teaching methods (e.g., collaborative teaching and learning, mathematics discourse) are enhanced by the integration of digital technologies like Wiki, WebQuest, Skype, and other communication and social networking programs; however, one of them can be better than the others based on its affordances and constraints toward the selected teaching strategy.

Figure 7

*Technological Pedagogical Content Knowledge (TPACK) (source: http://www.tpack.org/)*




The technological pedagogical and content knowledge (TPACK) was postulated to have four major components that also can be used as criteria to evaluate teachers' TPACK (Niess, 2005, 2012):

1. *An overarching conception about the purposes for incorporating technology in teaching subject matter topics*. This requires teachers to have a foundational understanding of what it means to teach a particular subject with digital technologies.
2. *Knowledge of students' understandings, thinking, and learning in subject matter topics with technology*. This requires teachers to have a comprehensive understanding of students' thinking and learning process with the present of digital technologies in their teaching for a particular subject matter.

3. *Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics*. This requires teachers to have a solid understanding of curriculum and all teaching materials and what affordances and constraints digital technologies will offer to their curriculum objectives.
4. *Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies*. This requires teachers to understand how to build a reciprocal relationship between his or her teaching methods and the best match digital technology that provides the best representation for a specific topic.

For mathematics, Niess and her colleagues (2009) proposed four TPACK standards and associated them with a five-step process TPACK developmental model in order to meet these standards. Their mathematics teacher TPACK standards have some indicators to guide the evaluation of each standard (see Table 1). These TPACK standards were later adopted by the AMTE, combined with ISTE Teacher Standards (NETS•T) (International Society for Technology in Education, 2008) and then published in their version of Mathematics TPACK framework (see Table 2) (AMTE, 2009).

Table 1

| | **Niess Research Group's Proposed Mathematics Teacher TPACK Standards** |
|---|---|
| 1. | **Designing and developing digital-age learning environments and experiences**<br>Teachers design and develop authentic learning environments and experiences incorporating appropriate digital-age tools and resources to maximize mathematical learning in context. |
| 2. | **Teaching, learning and the mathematics curriculum**<br>Teachers implement curriculum plans that include methods and strategies for applying appropriate technologies to maximize student learning and creativity in mathematics. |
| 3. | **Assessment and evaluation**<br>Teachers apply technology to facilitate a variety of effective assessment and evaluation strategies. |
| 4. | **Productivity and professional practice**<br>Teachers use technology to enhance their productivity and professional practice. |

Table 2

| Mathematics TPACK (Technological Pedagogical Content Knowledge) Framework |
| --- |
| 1. **Design and develop technology-enhanced mathematics learning environments and experiences.** Educators use their knowledge of technology, pedagogy, and content to design and develop learning environments and experiences to maximize mathematics learning. |
| 2. **Facilitate mathematics instruction with technology as an integrated tool.** Educators implement curricular plans that integrate appropriate technology to maximize mathematical learning and creativity |
| 3. **Assess and evaluate technology-enriched mathematics teaching and learning.** Educators assess and evaluate mathematics teaching and learning using appropriate assessment tools and strategies. |
| 4. **Engage in ongoing professional development to enhance technological pedagogical content knowledge.** Educators seek, identify, and use technology to enhance their knowledge, productivity, and professional practice. |

The five levels of TPACK development were inspired by Rogers' five stages of Innovation-Decision Process Model (Rogers, 1995). Niess, Suharwoto, Lee, and Sadri (2006) defined each level as follows:

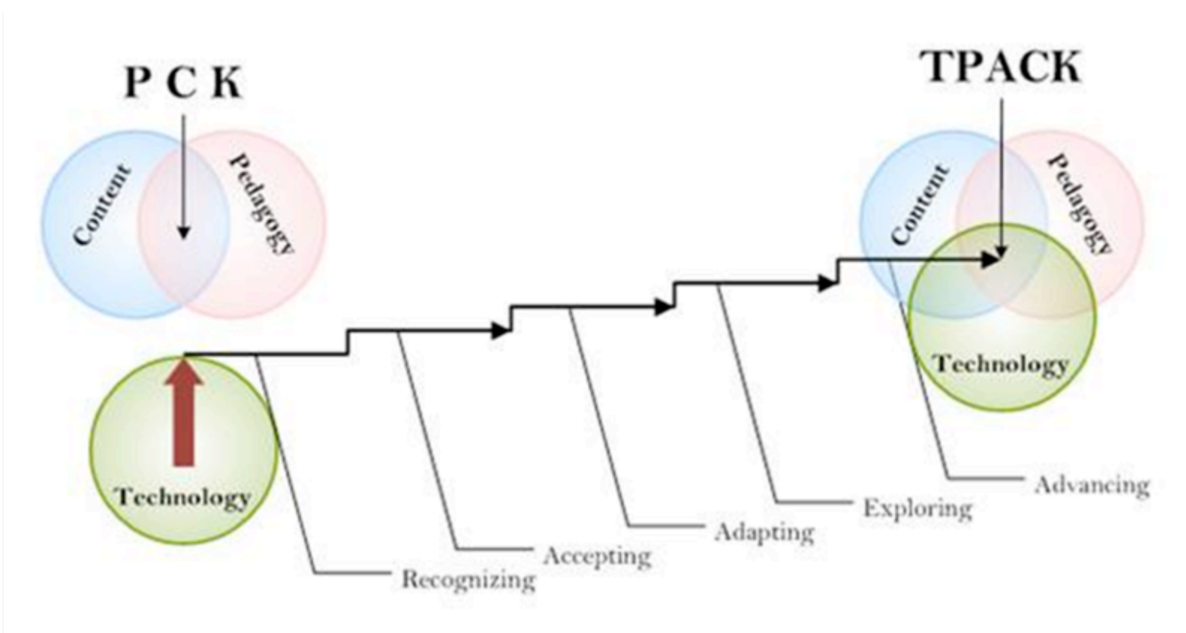
1. *Recognizing* (Knowledge): Teachers at this level can use a specific digital technology and judge its capabilities with a particular subject topic.
2. *Accepting* (Persuasion): Teachers at this level develop an attitude open to the integration of digital technology in their teaching but might not understand the potential role of technology in their teaching.
3. *Adapting* (Decision): Teachers at this level are capable, after an experience, of deciding whether to adopt a specific digital technology in their teaching for a particular subject topic.
4. *Exploring* (Implementation): Teachers at this level start to actively integrate digital technologies in their teaching practices for a particular subject topic.

5. *Advancing* (Confirmation): Teachers at this level are capable of evaluating the effectiveness of integrating a specific digital technology in their teaching for a particular subject topic.

These TPACK levels provide helpful guidelines for educators and researchers to plan, examine, improve, and evaluate the process of integrating digital technologies in teaching (see Figure 8). They also show the importance of interaction and engagement mathematics teachers need to have with all three domains of knowledge during the integration of digital technologies. In addition, teacher education and professional development programs should be designed, applied, and evaluated according to these TPACK standards and developmental levels.

Figure 8

*Five Level Model of TPACK Development source: (Niess et al., 2009)*

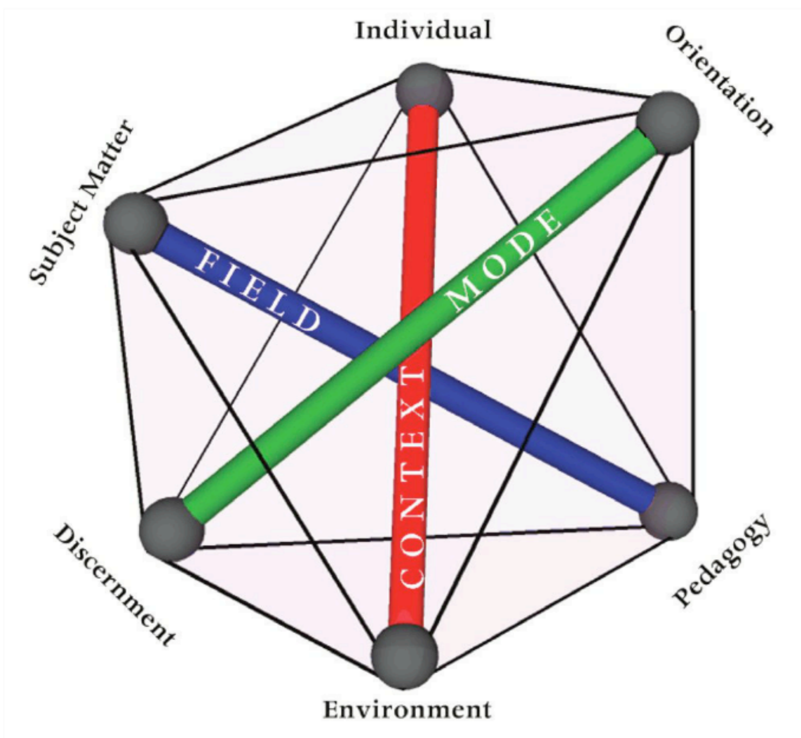



TPACK as a framework of thinking is wide enough to include three domains of knowledge yet narrow enough to be specific for certain topic, grade level, settings, and students' needs (Niess, 2012). Those three domains of knowledge should not be taken by mathematics teachers in isolation of one another but in interactions with each other and within their contexts (Mishra & Koehler, 2006). Therefore, Teacher Knowledge is described in the Comprehensive Framework for Teaching Mathematics (CFTK) with a large circle of interactions between six components (Individual, Environment, Orientation, Discernment, Subject Matter, and Pedagogy) (Ronau et al., 2010). These components of knowledge are engaged in three-dimensional structures, but they also can interact with every other component. The direct interaction between a teacher's knowledge of subject matter and pedagogy forms the first dimension, Field, and this construct produces pedagogical content knowledge but with wide interaction. The second dimension, Mode, consists of the interaction between orientation (knowledge of understanding and managing the impact of personality features on learning process) and Discernment (knowledge of understanding the impact of cognitive domain on learning process). The interaction of the Mode dimension produces for teachers a dynamic knowledge base to be used for managing multiple internal influences on student learning. The Context dimension has two aspects: individual and environment, both of which represent external factors on the teaching and learning process. The individual component explains the knowledge of individual factors, such as gender, age, socioeconomic status (SES), etc. that influence the learning situation and that teachers must understand and manage in order to effectively teach. The environment aspect describes the knowledge of the environmental impact, such as school climate, classroom climate, and other classroom, school, and community factors, on learning (see Figure 9).

The interactions between and among all three dimensions provides a wide picture of the knowledge of teacher with guidelines and explanation of how the National Council of Teachers of Mathematics (NCTM) teacher standards can be met and how digital technologies can be effectively integrated in teaching mathematics (Ronau & Rakes, 2012a). Mathematics teachers are speculated to reach the advancing level of effective integration of digital technologies TPACK when they have active and effective interactions between all aspects in CFTK model (Ronau et al., 2010).

Figure 9

*Comprehensive Framework for Teaching Mathematics (CFTK) source:(Ronau & Rakes, 2012a)*




**Effectiveness Evaluation**

Evaluating the effectiveness of teaching or its quality is usually done either through subjective or objective measurements. Seven common approaches evaluate an instructional performance. Variance between and among these evaluation methods depends upon the purpose of evaluation and the definition of teacher effectiveness, specifically whether it is indicated by teaching performance or student achievement (Eisner, 2002; O. Little, Goe, & Bell, 2009; Strong, 2011). Qualitative measures like peer and principal classroom observations and self-, principal, and student evaluations are exemplary of such approaches that have limitations on their validity and reliability. They evaluate teachers' morals and beliefs, attitudes, behaviors, and teaching ethics. These types of measures have limitations on their validity and reliability due to the biases of the observer and the cognitive demands of the task (Strong, 2011). On the other hand, quantitative measures like value-added modeling, teacher portfolios, teaching artifacts, and teacher aptitude tests have less validity and reliability threats. In fact, student achievement (rather than measuring teachers' teaching performance or examining their knowledge) is the most common scale for evaluating teacher effectiveness. The following paragraphs explain each evaluation method and detail its advantage and shortcomings.

**Value-added measures.** The value-added models, a statistical process for measuring teacher effectiveness by comparing student achievement scores in more than one year, came as a result of the emerging public call for educational accountability after the technical report of Sanders and Rivers in 1996 (Kupermintz, 2002; McCaffrey, Lockwood, Koretz, & Hamilton, 2003). The state of Tennessee had the initiative to adopt the first version of value-added models of assessment (the Tennessee Value-Added Assessment System (TVAAS)), a statistical system of analysis developed by Williams Sanders and Robert McLean from the University of Tennessee (Sanders & Horn, 1994), as part of its education reform package in 1992, before other states like Iowa, Ohio, Colorado, and Pennsylvania started to utilize in their accountability systems (Tucker & Stronge, 2005). Also, the Dallas Independent public school system was a pioneer in adopting another form of value-added model with more considerations to student and school characteristics (Goe, 2008).

The primary purpose for this mixed-model methodology educational assessment was to evaluate the effects of the entire school system, including teachers, principals, superintendents and school board member, on student achievement. However, the model was eventually used, fundamentally, to examine teacher effectiveness most of all. All value-added models were employed to support the claim that student achievement is an indicator of teacher effectiveness (Bracey, 2004; McCaffrey et al., 2003; McCaffrey, Lockwood, Koretz, Louis, & Hamilton, 2004; Nye et al., 2004; Tucker & Stronge, 2005). However, this claim is short of an articulated definition for teacher effectiveness and how it causes the change in student achievement (Ding & Sherman, 2006), although there is an attempt to consider all teacher, student, and school variables in a hierarchical linear model study (Odden, Borman, & Fermanich, 2004). This tool of educational measurement was expected to provide valuable information about students' learning growth and identify what factors affect student achievement (McCaffrey et al., 2003), but it does not serve all policy purposes and cannot be taken as the only source of evidence to make a high-stakes decisions.

As a research based assessment model (Fallon, 2004), the value-added models (VAM) are deployed to tackle the effectiveness of teaching by measuring the growth of student achievement over a wide range of trajectories rather than evaluating the difference in student achievement scores between a sequence of two years (e.g., *cohort-to-cohort change models*) (Koretz, 2008; Sanders, 2006). Value-added models were claimed to be more objective and valid measures of teacher quality (Sanders & Rivers, 1996) than other traditional teacher quality measures; however, evidence of their validity and reliability is not strong enough to allow them to be taken as the only basis for high-stakes decisions (e.g., hiring or dismissing a teacher) (National Research Council and National Academy of Education, 2010). Value-added models employ the Univariate Response Model to analyze a longitudinal data of student scores in multiple cohorts (Sanders, 2006). Value-added models are supported as a robust model of measurement when the effect of student characteristics is controlled (McCaffrey et al., 2004).

Despite these strengths, some shortcomings are associated with the value-added models. First, such models' validity and reliability are questionable since these models are limited to include differences between and among teachers (such as their practices, courses, and time frame), bias measurement, and measurement error, and unstable and nonrandom assignment of student and teacher is also a major threat to the validity of such measurement (National Research Council and National Academy of Education., 2010; Newton, Darling-Hammond, Haertel, & Thomas, 2010a). Second, such models became less user-friendly with the increased interest in making them more statistically complicated (Amrein-Beardsley, 2008; National Research Council and National Academy of Education., 2010). Third, there is an associated ambiguity in the assumption linking teacher effectiveness scores to teacher quality and in the possibility of a statistical solution to allocate the influence of each teacher in student achievement (Doran & Fleischman, 2005; D. Harris & Sass, 2006; Newton, Darling-Hammond, Haertel, & Thomas, 2010b), and a small sample size can hinder the accuracy of value-added estimates about teacher effectiveness (National Research Council and National Academy of Education., 2010). Fourth, the validity of value-added interpretations is difficult with its assumption of reporting tests result on an equal interval scale. This technical assumption for regression models is hard to meet with the current scale of reporting test scores and even with the item response theory scale that produces non-corresponding interval scales to society values of differences in intervals. Fifth, with the requirements of large data quality for the longitudinal analysis of the value-added models, the threat of missing or faulty data is presented (Amrein-Beardsley, 2008). Sixth, the use of the value-added models only for the summative evaluation purposes may lead to unintended consequences because of the obstructive incentives associated with its indicators (E. L. Baker, 2010). For example, schools may start to teach to the test instead of following their learning and teaching objectives, and cooperation may start to decrease among teachers and schools because of the feeling of competition. Finally, the value-added models narrow curriculum and focus on the achievement trajectories of students instead of the learning trajectories (Newton et al., 2010b). The learning trajectories have broader objectives than the achievement trajectories, which only represent student score growth for limited number of standardized test questions that are not necessarily reflect all learning objectives. Therefore, the VAM should not be taken as the only source of teaching quality evidence; instead, assessment should include other sources of evidence such as classroom observations and lesson artifacts, etc. (Koretz, 2008; Kupermintz, 2002; Strong, 2011; Tucker & Stronge, 2005).

**Self-Evaluation.** When teachers' intentions, knowledge, and beliefs about teaching are the objectives of measurement, this method of measuring teacher quality is usually favored for its low cost. In this model, teachers are prompted to report their behaviors and practices in the classroom into questionnaires, logs, interviews, or diaries. The variation in the collection methods is related to the variety of the focus (broad or specific), the purpose of use (summative or formative), and the quality and quantity of data the self-evaluation is intended to gather (O. Little et al., 2009; Mullens, 1995). Questionnaires may include checklists, rating scales, or frequency of use measures, depending on the purpose of use. As a subjective performance assessment, its validity is limited by the bias of teachers' self-perception; however, logs were found to be as valid and reliable as classroom observation (Camburn & Barnes, 2004; Rowan & Correnti, 2009). However, all types of self-evaluation provide questionably accurate and valid data, potential problems caused by teacher's inflated information (Strong, 2011). Factors like time of responding to questions and complexity of vocabularies may limit the quality of teacher responses (Blank, Porter, & Smithson, 2001).

**Classroom observation**. Classroom observation is highly credible among educators as the most direct method of evaluating teacher effectiveness in contexts (O. Little et al., 2009). In addition, observation protocols vary in their objectives, procedures, subject matter, grade level, complexity, observer requirements (knowledge, training), durations, frequency, and validity and reliability level (O. Little et al., 2009; Strong, 2011). Examples of observation protocols are researcher-made or published ones like Charlotte Danielson's Framework for Teaching, The Classroom Assessment Scoring System (CLASS), The Protocol for Language Arts Teaching Observation (PLATO), Mathematical Quality of Instruction (MQI), and Teaching Standards and Performance Rubrics. Some evidences points to the validity and reliability of such measures to evaluate teacher effectiveness, and researchers who have collected this data use evaluations based on classroom observation as a predicator for student achievement (Gallagher, 2004; Kimball, White, Milanowski, & Borman, 2004; Milanowski, 2004); however, there is still need for more research, especially since evaluators' training and inter-rater reliability are common concerns about classroom observation as a teacher effectiveness measure.

**Artifacts analyses.** Teaching artifacts are good sources of information about teacher effectiveness since they present more valid information about their pedagogy and instructional activities. Analyzing randomly selected teaching materials like lesson plans, student homework, classroom activities work sheets, and assessment tasks and then measuring their relationship to student learning or achievement trajectories are examples for such evaluation measurer (O. Little et al., 2009). The criteria for evaluating each type of teaching artifacts can vary from one research study to another, depending on the purpose of evaluation (e.g., aligning with standards, supporting 21st century learning skills, integrating technologies) (Strong, 2011). Therefore, existing protocols for evaluating teaching artifacts are different based on their focus and how structured they are (e.g., Scoop Notebook, Instructional Quality Assessment (IQA), Intellectual Demand Assignment Protocol (IDAP)) (O. Little et al., 2009; Strong, 2011). Validity and reliability threats to such objective measure are limited in comparison to subjective ones, though rater knowledge of the content and experience and scoring criteria may negatively affect the data quality. However, analyzing artifacts of teaching is a practical and cost-efficient measure to conduct both summative and formative evaluation for teacher effectiveness, and its accuracy and consistency of data quality is comparable to those obtained from classroom observations (O. Little et al., 2009; Strong, 2011).

**Portfolio analyses.** This tool of teacher quality evaluation is intended for the formative assessment and provides teachers the opportunities to reflect upon their teaching effectiveness. It also helpful for providing information about teachers' instructional practices that cannot be collected by other teacher effectiveness measures (e.g., classroom observation)(O. Little et al., 2009; Strong, 2011). The teaching materials included in portfolios are similar to those in artifacts (e.g., lesson plans, assignments, assessment tasks, etc.); however, they are selected by teachers and may not have been implemented yet (O. Little et al., 2009; Strong, 2011). Portfolios are often used for licensure purposes in teacher preparation programs; however, they have been employed as a teacher quality evaluation tool by different states (e.g., Vermont, Connecticut, Washington) (O. Little et al., 2009; Strong, 2011). This method of evaluation has some strengths and shortcomings as well. Portfolios can include a broad range of teaching materials (observable and non-observable) from various contexts (e.g., subject matter, grade level, etc.)(O. Little et al., 2009). Portfolios evaluation has high face validity from the perspective of teachers and administrators; however, teachers need to have the ability to select the appropriate teaching materials for the evaluation purposes (formative or summative) (O. Little et al., 2009; Strong, 2011). Evidence for the reliability and validity of portfolios does not strongly support their use as the only basis for high-stakes decisions (O. Little et al., 2009; Strong, 2011). Non-standardized criteria for selecting and evaluating portfolios limited the inter-rater reliability of this method of teacher quality evaluation (O. Little et al., 2009; Strong, 2011).

**Student evaluation.** With their daily interactions with teachers, students, as the recipients of instructions, are qualified to judge the performance of their teachers at least in terms of their characteristics and teaching ethics (O. Little et al., 2009; Strong, 2011). In this form of teacher evaluation, students are asked to rate their teachers' general teaching practices and behavior on a 4 or 5-point Likert scale, but the scale has to be well designed to increase its validity and reliability (O. Little et al., 2009). Students' personality factors affect their rating bias (leniency and halo errors), especially given students' lack of knowledge of content, pedagogy, classroom management, and other teacher quality areas. Student evaluation is still low cost and non-time consuming and is found to provide valuable information about teacher behavior and practices, especially when feedback is from secondary and college students (Follman, 1992, 1995).

**Principal evaluation.** Teacher evaluation that is conducted by principals and vice principals through classroom observations is commonly done for high-stake decisions (Brandt, Mathers, Oliva, Brown-Sims, & Hess, 2007), although such evaluation type, whether formal or informal, can be used also for formative purposes (Downey, Steffy, English, Frase, & Poston, 2004; Heneman, Milanowski, Kimball, & Odden, 2006). School administrators, in positions that give them opportunities to observe and interact with teachers on a daily basis and access much information about their teachers, are very good candidates to provide a valid and reliable evaluation (O. Little et al., 2009; Strong, 2011). However, principals usually do not receive appropriate training on how to implement a valid and reliable teacher evaluation (Brandt et al., 2007). In addition, their evaluation can be biased by their personal interpretation of teaching behavior (O. Little et al., 2009; Strong, 2011). In research, principal evaluation is not strongly supported to be a predicator of teacher effectiveness. The relationship between principal evaluation and teacher effectiveness (measured mostly by student achievement) ranged from not significant (Wilkerson, Manatt, Rogers, & Maughan, 2000) to weak (Bommer, Johnson, Rich, Podsakoff, & MacKenzie, 1995; D. Harris & Sass, 2009; Jacob & Lefgren, 2008; Medley & Coker, 1987; Murnane, 1975). Principal ratings of teachers were compared to other methods of teacher effectiveness evaluation and were found more valid and reliable in predicating teacher effectiveness than proxy measures (e.g., certification, experience, major) and as accurate as value-added models (D. Harris & Sass, 2009), whereas other researchers found it less valid and reliable than value-added models (Jacob & Lefgren, 2008) and student ratings of teachers (Wilkerson et al., 2000). Threats of validity and reliability in principal evaluation came from low level of training, low observation frequency, and infrequent use of protocols or rubric for evaluations (O. Little et al., 2009; Strong, 2011). However, this teacher effectiveness measure has been selected for this study because it is more practical and more valid and reliable than traditional measures of teacher quality.

**Mathematics TPACK in Research**

Polly (2011) investigated the influence of TPACK of two mathematics teachers on their integration of digital technologies. In this study, one fifth and one eighth mathematics teachers had been trained for 30 hours of TPACK learner-centered professional development (LCPD) project and then received a follow-up training in their schools. They were next interviewed and observed to measure their integration of digital technology and how it is related to the TPACK professional development. The results showed that both teachers applied what they had learned in the TPACK professional development and their students slightly developed higher-order thinking skills and relational understanding of matheamtics concepts.

Polly (2011) recommends designing a comprehensive TPACK professional training that allows in-service mathematics teachers to develop a conceptual and procedural understanding of the concept of mathematics TPACK. Therefore, these professional programs have to be long enough and sufficiently content-specific to achieve these objectives.

Lyublinskaya and Tournaki (2012) examined how professional development of content authoring influences mathematics teachers TPACK development and in turn affects their students' algebra achievement scores. After a one-year professional training spent creating curriculum that integrates TI-Nspire technology, four Algebra teachers from a New York City public high school were evaluated for their TPACK developmental levels. Researchers utilized their developed TPACK Levels Rubric to measure teachers' artifacts and their teaching practices. Their results indicated the importance of lesson plan preparation in teacher effectiveness and the impact of teachers' TPACK levels on student achievement. They also found that the growth of TPACK levels is not linearly or consistently developed. Lyublinskaya and Tournaki (2012) recommended that professional development program designers provide mathematics teachers with the time, feedback, and collaboration support needed to improve their lesson plan designing.

Jang and Tsai (2012) developed a study to investigate how the implementation of Interactive Whiteboards affects in-service elementary mathematics and science teachers'

TPACK self-efficacy in Taiwan. They analyzed the responses of 614 elementary mathematics and science teachers to their TPACK questionnaire. They found that Interactive Whiteboards teacher users had higher TPACK self-efficacy than others who did not use them. They also found that teaching experience and subject matter, but not gender, were significant factors in explaining the variance of teachers' TPACK.

Bos (2011) conducted a mixed method study to examine how learning about the integrated use of technology, pedagogy, mathematics, and cognitive complexity would affect the knowledge structure of 30 elementary urban mathematics teachers and help them in designing their lesson plans. The study implemented the TPACK framework with practicing teachers in developing their lesson plans using Web 2.0 instructional tools and mathematical objects. Then the relationship between teachers TPACK and technology integration was measured. The growth of teacher TPACK was evaluated by peer evaluation on a 5-point scale, and results indicated that teachers disagreed about the conceptual approach of integrating digital technology in their teaching practices. The researcher also indicated that there was a lack of clarity in the TPACK construct that related to teacher practice.

Richardson (2009) conducted a project to measure mathematics teachers' TPACK development. The sample was comprised of 20 eighth-grade mathematics teachers from three different rural and three urban schools. Teachers received 120 hours of professional development training to improve their TPACK. The data were collected through journal entries and observations of interactions and discussion between teachers and was then evaluated according to the TPACK framework. The results showed the importance of evaluating TPACK as interacting domains of knowledge rather than isolated ones. In addition, this study emphasized the importance of providing mathematics teachers with professional training that develops and advances their integration of digital technologies.

**TPACK Assessment**

The technological pedagogical content knowledge (TPACK) as a new domain of knowledge is still in its infancy in matter of application and evaluation. However, the major types of assessing the TPACK and its impact on teacher quality are similar to those used to evaluate teacher effectiveness. Various types of measures include self-evaluation measures such as questionnaires (open-ended and close-ended) and interviews, logs, reflective journals, and diaries; classroom observation (standardized and unstandardized protocols and rubrics); and the evaluation of teaching artifacts (lesson plans, student work, classroom activities and teaching materials). These measurement types are equally utilized in empirical research studies except open-ended surveys that might be limited by their practicality difficulties (for example, coding, analyzing) (Koehler, Shin, & Mishra, 2012)

Measuring knowledge is hard because of its invisibility; therefore we can only measure its effects on our behaviors and actions (Hunt, 2003). TPACK measurement tools should be valid to evaluate the reflections of this knowledge on teachers' action (instruction design, lesson plans, classroom activities, assessment tasks) and correlate such knowledge with teaching effectiveness. The design of TPACK evaluation tool and the interpretation of its data should respond to the definition of TPACK and its objectives and be consistent. Multiple ways of measuring such knowledge will provide a rich foundation for our decision about whether teachers have acquired the TPACK.

Reliability and validity tests for available TPACK measurement tools are minimal (Koehler et al., 2012). The apparent reason for the dearth of investigating and assessing TPACK is related to the complex nature of TPACK, the multiple content areas needed to be included, various target groups (e.g., experienced and prospective teachers, etc.), and the fast growing development of digital technologies (Koehler et al., 2012).

Evaluating TPACK in self-report measures is usually conducted through seven subscales (TK, CK, PK, PCK, TCK, TPK, TPACK) that comprise the full concept of TPACK (e.g., Archambault & Crippen, 2009; Koehler, Mishra, & Yahya, 2007; Schmidt et al., 2009). In such measures, participants rate their agreement with given statements in each subscale, and then their rating is calculated as indicator of their TPACK self-efficacy, not their actual knowledge (K. A. Lawless, Kulikowich, & Smith, 2002; Kimberly A. Lawless & Pellegrino, 2007).

Other measures only focus on the TPACK intersection subdomains (TCK, TPK, TPACK). Harris, Grandgenett, and Hofer (2010) developed their rubric to assess the three subdomains (TCK, TPK, TPACK) by evaluating the lesson plans of their prospective teachers based on four levels of TPACK proficiency. They have adopted the Technology Integration Assessment Instrument (TIAI) (Britten & Cassady, 2006) and then tested and confirmed their rubric validity and reliability.

Lyublinskaya and Tournaki (2012) measured TPACK from another prospective. They constructed their TPACK Levels Rubric based on the four components of TPACK (Niess, 2010b), the five levels of TPACK development model (recognizing, accepting, adapting, exploring, and advancing) (Niess et al., 2009), and the Principles for a Practical Application of TI-Nspire technology (Dick & Burrill, 2009) (since it is a content-specific form). Researchers have used their rubric to analyze teacher artifacts; however, it can be used for direct evaluation as an observation protocol, too. The rubric has strong face validity; however, reliability and validity analyses for this new developed rubric are still in process (Lyublinskaya & Tournaki, 2012).

## Summary

This chapter provided a theoretical background of teacher effectiveness and how it is measured; explored teacher knowledge of technology, pedagogy and content and how TPACK is measured; and reviewed current mathematics TPACK research.

# CHAPTER III

# METHODOLOGY

## Introduction

This chapter provides an overview of the research methodology, procedures, and design used in the study. This includes: the research questions, descriptions of participants, procedures, data collection techniques, instrumentations, and data analysis.

The main question for this study is: How does the self-perceived expertise of 7-12 grade Saudi Arabian mathematics teachers in technology integration, teaching pedagogy, and mathematics content relate to their teaching effectiveness?

The teachers' self-perceived knowledge of technology, pedagogy, and content (TPACK) is measured by a self-rate questionnaire, and the teaching effectiveness is measured by principal ratings of mathematics teachers. The study sample included secondary school male mathematics teachers in Riyadh public schools. The administrator and teacher questionnaires were mailed to each school with instructions that show principals how to obtain teachers' input and record their own evaluations of teachers. Univariate descriptive statistics, Pearson correlation coefficient, two-way analysis of variance (ANOVA), Paired-Samples t-test, and Multivariate Analysis of Variance (MANOVA) analyses were used to evaluate the relationship between teachers' knowledge in technology, pedagogy, and mathematics content (TPACK) and their teaching effectiveness.

## Research Questions

The questions developed for the study focused on teachers' self-perceived expertise in technology, pedagogy, and mathematics content areas of knowledge and its relationship with teacher effectiveness.

Research Question 1: What is the self-perceived expertise of 7-12 grade Saudi Arabian mathematics teachers in 1) technology, 2) teaching pedagogy, and 3) mathematics content, including the combinations of these domains?

Research Question 2: Is there a significant linear relationship between teacher effectiveness and mathematics teachers' self-perceived knowledge in technology, pedagogy, and mathematics content and the intersections between them?

Research Question 3: What is the perceived preparation level of Saudi Arabian 7-12 grade mathematics teachers in integrating digital technologies in their teaching?

Research Question 4: Is there a significant linear relationship between teacher effectiveness and preparation level in integrating digital technologies in teaching mathematics?

Research Question 5: Is there a significant linear relationship between the perceived knowledge and preparation level of Saudi Arabian 7-12 mathematics teachers with respect to digital technologies integration?

Research Question 6: Is there a significant relationship between mathematics teachers' demographic variables (age, level of education, number of teaching grade level, classroom size, major, school of graduation, teachers' aptitude test scores, years of teaching mathematics, years of teaching other subject matter, and teaching experience) and their teaching effectiveness?

Research Question 7: Is there a significant relationship between mathematics teachers' ratings of their level of anxiety with teaching mathematics and their teaching effectiveness?

Research Question 8: Is there a significant relationship between mathematics teachers' ratings of their level of anxiety with integrating technology in their teaching and their teaching effectiveness?

**Research Hypotheses**

There are eight directional and nondirectional correlational research hypotheses for this study. These research hypotheses will correspond to the above research questions:

H1. Saudi Arabian 7-12 mathematics teachers rate themselves high on their knowledge of technology, pedagogy, and mathematics content and the intersections between these three domains of knowledge.

H2. There is a statistically significant linear relationship between mathematics teachers' self-perceived knowledge in technology, pedagogy, and mathematics content and their teaching effectiveness.

H3. Saudi Arabian 7-12 mathematics teachers rate their level of preparation as high in integrating digital technologies in teaching mathematics.

H4. There is a statistically significant linear relationship between teacher effectiveness and preparation level of integrating digital technologies in teaching mathematics.

H5. There is a statistically significant linear relationship between the perceived knowledge and preparation level of Saudi Arabian 7-12 mathematics teachers with respect to digital technologies integration.

H6. There is a statistically significant relationship between mathematics teachers' demographic variables (age, level of education, number of teaching grade level, classroom size, major, school of graduation, teachers' aptitude test scores, years of teaching mathematics, years of teaching other subject matter, and teaching experience) and their teaching effectiveness.

H7. There is a statistically significant relationship between the level of anxiety with teaching mathematics and teacher effectiveness

H8. There is a statistically significant relationship between the level of anxiety with teaching with technology and teacher effectiveness.

**Participants**

**Description.** The target population for this study is mathematics teachers in Saudi public schools. According to the *Annual Program of Statistical Work* report released by the Information Department at the General Department of Information Technology in the Ministry of Education, 37,231 mathematics teachers taught in Saudi Arabia public schools during the 2008-2009 school year, 18,112 males and 19,119 females (Ministry of Education in Saudi Arabia, 2009). The largest number of workers in the education field is in the age range of 30 to 35, with 25% of teachers in this bracket in 2009 (Central Department of Statistics Information in Saudi Arabia, 2009). The percentage of qualified mathematics teachers who hold educational degree of bachelor or above is 77%; the rest have degrees in subjects other than education or have two-year diplomas only (Ministry of Education in Saudi Arabia, 2009). The majority had their degree in mathematics education or mathematics (Mullis et al., 2008). Also, 94 percent of teachers teaching mathematics during the school 2008-2009 year in Saudi Arabia are Saudi (Ministry of Education in Saudi Arabia, 2009). These mathematics educators teach 4,211,936 students in 24,855 public schools. In the capital city Riyadh, where the sample was recruited, 2020 mathematics teachers taught 293,058 students in 728 public schools in 2008-2009; 499 teachers of this population taught in middle public schools, and 318 were high public school mathematics teachers (General Directorate of Education in Riyadh, 2009).

Mathematics teachers who graduated from Saudi universities with bachelor degrees are usually required to take one course in computer programming (3 credit hours) and at least four courses in educational technology. The Ministry of Education through the Department of

Educational Training provides annual professional training programs in mathematics content, mathematics pedagogy, mathematics curriculum, technology integration into mathematics, improving students' critical thinking of problem solving skills, and mathematics assessment (Mullis et al., 2008). However, participation in these professional training programs is voluntary for most of the teachers, though first year teachers may be asked by school principals to attend one or two of these programs. The ministry of education motivates participation in these programs by giving teachers training points that count toward earning a higher position in their profession.

**Sampling.** The convenience method as a nonrandom sampling strategy was utilized to collect information from in-service secondary public school mathematics teachers in Riyadh since selecting an equal probability sample is impractical (Johnson & Christensen, 2010; Salkind, 2012). According to the calculation method, the minimum recommended sample size is 323 respondents for a confidence level of 95%, a margin of error of 5%, and a population size of 2020. However, with the consideration of 40 to 50 percent response rate, at least 646 mathematics teachers should be polled (Johnson & Christensen, 2010; Salkind, 2012). Only general education and male mathematics teachers were included in this study because they were easier to recruit.

## The Research Design

A descriptive – correlational research design was employed to investigate the relationship between the dependent (criterion) variable (teacher effectiveness) and the independent (predictor) variables (mathematics teachers' self-perceived knowledge of technology, pedagogy, and mathematics content, mathematics teachers' preparation level, mathematics teachers' demographic variables and teachers' anxiety level regarding teaching mathematics and integrating technology) and then predict the outcome based on an understanding of that relationship (Johnson & Christensen, 2010).

Niess' mathematics TPACK development model (Niess et al., 2009), the National Educational Technology Standards for Teachers (NETS•T) (International Society for Technology in Education, 2008), the Professional Standards for Teaching Mathematics (National Council of Teachers of Mathematics, 1991), and the Mathematics TPACK Framework (AMTE, 2009) were selected as the theoretical frameworks for this study in order to examine the relationship between the mathematics teachers' self-perceived expertise in technology, pedagogy, and mathematics content areas of knowledge and their teaching effectiveness.

**Data Collection Plans**

**Description of variables.** The independent variables in this study are (a) mathematics teachers' self-perceived knowledge in technology, pedagogy, and mathematics content (TK, CK, PK, PCK, TCK, TPK, and TPACK); (b) mathematics teachers' self-perceived preparedness for digital technology integration in teaching mathematics; (c) mathematics teachers' self-rating of their level of anxiety about teaching mathematics and using technology; (d) grade of teaching; (e) teaching experience; (f) years of teaching math; (g) years of teaching other subject(s); (h) level of education; (i) major; (j) teachers' aptitude test scores; (k) classroom size; (l) school of graduation; and (m) age. The dependent variable in this study is teachers' effectiveness, which is measured by principal evaluation of mathematics teachers. In some research, school administrator evaluations were equally significant to the value-added measures at assessing the most and least effective teachers and outperformed the validity of traditional proxies of teacher quality (e.g., educational level, teaching experience) at predicting the future student achievement (Jacob & Lefgren, 2006, 2008). In addition, obtaining teachers' evaluation from school administrators was more practical in this study than a value-added model especially with the absence of standardized tests in Saudi public schools (Hammond, Alexander, & Bodzin, 2012; Strong, 2011).

**Research instruments.** The objectives of this study were to obtain mathematics teachers' self-evaluation and perceptions about their knowledge of technology integration, pedagogy, and mathematics content and its relationship with their teaching effectiveness. Therefore, questionnaires were used as the data-collection instrument to achieve these objectives (Johnson & Christensen, 2010; Salkind, 2012).

Two surveys, one for mathematics teachers (see Appendix E) and another for school administrators (see Appendix H), were used to gather data. The teacher's questionnaire had four parts (46 items). The first part included 28 items to measure participants' technology, pedagogy, content domains, and subdomains knowledge (TK, CK, PK, PCK, TCK, TPK, TPACK). There were four items in seven subscales in this part, and all used a five-point Likert-type scale: (1) strongly disagree; (2) disagree; (3) neither agree or disagree, (4) agree; and (5) strongly agree.

On the first subscale, participants self-evaluated their technology knowledge (TK) by responding to four statements such as "I know how to use different digital technologies."

The second subscale, content knowledge (CK), had four statements such as "I am able to communicate mathematically," and participants measured their knowledge of the mathematics content by rating their level of agreement with each statement.

The third subscale, pedagogy knowledge (PK), measured participants' knowledge of teaching methods and processes with four statements such as "I know how to assess student performance in a classroom."

Pedagogical content knowledge (PCK), the forth subscale, had four statements such as “I have a good understanding of teaching mathematics so that students are able to learn” to evaluate mathematics teachers’ knowledge of mathematics teaching methods and processes.

Technological content knowledge (TCK), the fifth subscale, included four statements such as “I am able to use digital technologies to explore mathematical ideas” to assess mathematics teachers’ understanding of how technology can enhance the learning of mathematics.

The sixth subscale, technological pedagogical knowledge (TPK), encompassed four statements such as “I can adapt digital technologies to support learning in my classroom” to measure how mathematics teachers understand the role of digital technologies in their teaching practices.

The seventh and last subscale, technological pedagogical content knowledge (TPACK), consisted of four statements such as “I can select digital technologies to use with specific instructional strategies as I guide students in learning mathematics” to evaluate how mathematics teachers are knowledgeable to integrate digital technologies effectively in their teaching.

The second part of the teachers’ survey included five questions to evaluate mathematics teachers’ self-perception about their preparedness to teach mathematics with technology. These questions asked participants about number of courses, hours of professional training, and average grades in mathematics, mathematics educational methods, educational technology, and technology areas. On a five-point Likert-type scale, teachers also evaluated whether their teacher education programs and professional training workshops prepared them to integrate digital technologies effectively in their teaching.

The third part had two items to examine teachers' anxiety level about teaching mathematics and integration technology in their teaching practices. An example of those items is a statement such as "I have anxiety about teaching with technology," and responses were quantified using a five-point Likert-type scale: (1) strongly disagree; (2) disagree; (3) neither agree or disagree, (4) agree; and (5) strongly agree.

The fourth part contained 11 items to elicit participants' demographic information (age, level of education, grade level, classroom size, major, school of graduation, teachers' aptitude test scores, years of teaching mathematics, years of teaching other subject matter, and teaching experience).

A definition for each term in the survey was provided for respondents to clarify any ambiguity about the meaning of any item in the questionnaire and to insure that every participant has the same level of understanding. In addition, all scales in this survey have equal-appearing intervals.

The second instrument is the principals' questionnaire (see Appendix H), which has one question with 14 items to measure teachers' effectiveness in various professional areas (e.g., teaching methods, effective use of technology, etc.) and utilized a scale of five rating levels (Lower 20%, Lower 50%, Upper 50%, Upper 25%, Upper 10%). Administrators were provided with listing form (see Appendix G) to record teachers' names and their survey numbers and use it to fill out their surveys. Then they destroyed it to ensure the confidentiality and anonymity of their teachers' information.

Each participating school received an envelope that included an invitation to participate in the study for the principal (see Appendix F) and mathematics teachers (see Appendix D), informed consent statements (see Appendix C), teachers' surveys (see Appendix E), listing form (see Appendix G), and teachers' effectiveness surveys (see Appendix H). Respondents were informed of the importance and the purpose of the study and assured of their confidentiality and anonymity prior to their participation. Principals also were reassured that their responses would be completely confidential and would not be revealed to the teachers.

**Validity and reliability of instruments.** The items of part one in the teachers' survey are adapted and modified from Hervey (2011), who measured the internal consistency reliability of the seven subscales (TK, CK, PK, TCK, TPK, PCK, and TPACK) and obtained coefficients alphas of .79, .66, .85, .80, .81, .85, and .86 respectively. Hervey (2011) used *Teachers' Knowledge of Teaching and Technology Survey* of Schmidt et al. (2009) and modified it to increase its validity to measure secondary mathematics teachers' TPACK. Since the target population for this study is also middle and high school mathematics teachers, so Hervey's survey is an appropriate selection for this study. Three more parts were added to the teachers' questionnaire in order to meet the study objectives and increase its validity.

The second instrument, the teachers' effectiveness survey, was adapted from Brennen (2011) and then modified to meet the objective of this study. There is no validity or reliability tests results found for this adapted instrument. This questionnaire was selected because it had 14 items that covered various areas of teaching proficiency and it was easy and fast for principals to complete, which was important since principals' eagerness to evaluate their mathematics teacher was assumed to low.

A focus group and a pilot study were conducted to measure the validity and the reliability of the research instruments. First, the focus group included experts in educational technology, mathematics education, and measurement and research methodology to evaluate the two questionnaires for content validity (see Appendix I). The first versions of the questionnaires (see

Appendix A &B) were revised and modified according to the recommendations and comments provided by the focus group to increase validity. The teachers' questionnaire underwent major changes, especially in part one, which measures mathematics teacher's TPACK. The number of items in each subdomain was balanced, with four items for each subdomain. The PCK and TPACK subdomains were modified to reflect the theoretical base of Grossman's four components of PCK (Grossman, 1989, 1990b) and Niess's four components of TPACK (Niess, 2005) respectively.

A pilot study was conducted to measure the reliability of research instruments. A total of 20 mathematics teachers and seven principals from four Saudi public middle (14 teachers) and three public Saudi high (6 teachers) schools participated in this pilot. All participants were representatives of the population of the study and convenience sampled. The reliability coefficients obtained from the pilot study were .78 and .75 for teachers and principal surveys respectively. These Cronbach's Alpha values indicated a high level of internal consistency of each item with the underlying construct and correlate performance on each item with overall performance across participants (DeVellis, 2003; Fowler, 1995; Johnson & Christensen, 2010; Salkind, 2012).

**Consent to conduct study.** Permission to conduct this study has been obtained from the Human Subjects Committee of the University of Kansas for the Protection of Human Subjects in Research (see Appendix J) as well from the *Directory of Education* in Riyadh (see Appendix K).

**Translation of the research instruments.** Since the participants in this study were Arabic-speaking mathematics teachers and principals in Saudi Arabia and the language might affect the validity of the instruments, the research questionnaires were translated from English into Arabic and validated using Brislin's model of translation (1970) (Behling & Law, 2000).

First, the researcher did the forward translation of original English Surveys to Arabic (source-to-target language translation). Second, a certified translator who speaks both languages and has a professional background in teaching English and Arabic as a second language did the backward translation of Arabic version to English version (target-to-source language translation). Third, the equivalency in meaning between the two English versions (original A and backward translation C) was examined by two native English speakers who hold Ph.D. and MA degrees in English Language and have professional background in TESL and graduate writing. The researcher developed an evaluation form (see Appendix L) to be utilized to document any difference identified during the equivalency test for the two English versions (A and C). The result showed only eight items in the teachers' questionnaire that needed to be modified to have an equal meaning. Therefore, both the researcher and the translator have reviewed both English versions (A and C) and Arabic version (B) to fix the nonequivalence in meaning between them and agree on the final version of the Arabic questionnaires. Finally, two Ph.D. candidates in linguistics and the teaching of English as a second language (TESL) who are native Arabic speakers evaluated the final English and Arabic versions (A and B) of teacher effectiveness and the teachers' surveys. They were asked to measure three writing features in the Arabic version: clarity, length of words and sentences, and the appropriateness of reading level for the target population (Johnson & Christensen, 2010). The result showed a high level of clarity and appropriateness of reading level, so few items were rephrased in response to the judges' comments (see Appendix M for panel of translation experts and Appendix N for final Arabic version of surveys).

**Data collection.** The research data was collected through the distribution of the Arabic version of the questionnaires (see Appendix N) to mathematics teachers and principals in the

Saudi public schools during the fall of 2011. Both principal and mathematics teacher surveys were delivered to each school in one envelope that included, in addition, informed consent statements and the Directory of Education approval letter. To protect the confidentiality of their schools' information, school administrators were given the role of administrating the questionnaires, collecting the information from their mathematics teachers, and evaluating their mathematics teachers. The written instructions that came with the questionnaires clearly described for principals the procedures of administering the surveys.

Participants were asked to respond to all questions in the questionnaires, which were provided in paper formats. The paper mode was been chosen because it was more practical than an online format given the unreliable availability of the Internet and was predicted to be more convenient for participants, as the pilot study participants recommended. Participants were provided with a written description of the purpose of the study and informed that participation in the study was voluntary and their responses would not be personally identifiable and no personal information would be published. Each participant's input was coded and analyzed using the SPSS (Statistical Package for the Social Science) software. The data collected was safely stored in the researcher's office and accessed by only the researcher and his advisor, Dr. Ronald Aust. The primary investigator will delete the data after one year of completing the study.

**Data Analysis**

Several statistical analysis tests were applied to the quantitative data. Univariate descriptive statistics, Pearson correlation coefficient, two-way analysis of variance (ANOVA), Paired-Samples t-test, and multivariate analysis of variance (MANOVA) were employed in this study to investigate the relationship between the DV (teachers' effectiveness) and IVs (teachers' perceived knowledge of technology, pedagogy, and mathematics content, perceived preparedness for technology integration in teaching mathematics, level of anxiety about teaching mathematics and using technology, grade of teaching, classroom size, years of experience, years of teaching math, years of teaching other subject, level of education, major, school of graduation, teacher aptitude test score, age). The level of significance for the statistical results interpretation was judged based on an alpha level of 0.05. The two-way ANOVA, Paired-Samples t-test, and MANOVA analyses were used to compare means between groups (school level, grade, age, etc.).

To test the first hypothesis, the researcher performed the following steps. First, descriptive statistics analysis conducted for teacher TPACK scale and then Pearson correlation coefficient was computed to test the relationships among the knowledge domains and subdomains. MANOVA also was measured to analyze the effect of different categorical variables like grade level on teachers' perceived knowledge of technology, pedagogy, and mathematics content.

For the second hypothesis, Pearson correlation coefficient was utilized to test the relationship between mathematics teachers' perceived knowledge of mathematics content, pedagogy, and technology and principals ratings of teachers' effectiveness.

For the third hypothesis, descriptive statistics analysis was conducted to measure how mathematics teachers evaluate their readiness to integrate digital technologies in their teaching.

For the forth hypothesis, Pearson correlation coefficient measured quality and quantity of educational technology courses in teacher education and in professional development and how they are related to teacher effectiveness. Two-way ANOVA tests were conducted to measure how means among groups are different across mathematics teacher participation in professional development programs during the current school year.

For the fifth hypothesis, bivariate correlation coefficients were computed between teachers' ratings for their knowledge of technology, pedagogy and mathematics content, and their level of preparation to effectively integrate digital technologies in their teaching. A MANOVA was employed to compare the means of receiving professional training in content areas (mathematics, mathematics education, educational technology, and technology) for each domain and subdomain of knowledge measured by TPACK scale.

For the sixth hypothesis, bivariate correlation analysis was conducted to examine the relationship between mathematics teachers' demographic variables (age, level of education, grade level, classroom size, major, school of graduation, teachers' aptitude test scores, years of teaching mathematics, years of teaching other subject matter, and teaching experience) and their teaching effectiveness.

For the seventh and the eighth hypotheses, the relationships between teacher effectiveness ratings and teachers' ratings of their anxiety with teaching mathematics and teaching with technology were measured by Pearson correlation coefficient.

**Summary**

This chapter discussed the methodology and procedures that were used to investigate the relationship between mathematics teachers TPACK and teacher effectiveness. It included research design, research questions and hypotheses, data collection procedures, target population, instrumentation, validity and reliability, and data analysis.

# CHAPTER IV

# RESULTS

## Introduction

This chapter presents the research results for investigating the influence of mathematics teachers' knowledge in technology, pedagogy, and mathematics content on their teaching effectiveness. The results include the demographics of the participants, the descriptive statistics of the data, the treatment of missing data, the validity and reliability analyses for research instruments, and the findings of the questions.

## Demographics

There were 206 Saudi public male-only schools (154 middle schools and 52 high schools) included in the study. Each school received by mail or in person an envelope that included five teachers' surveys and five principals' surveys, so a total of 1030 pairs of surveys were distributed. The total valid pairs of surveys received were 347 from 109 schools; 71 middle and 38 high schools. The participants included 214 middle school mathematics teachers (62%) and 133 high school mathematics teachers (38%). The response rate was 34%, which is lower than expected.

**Age.** The age of mathematics teachers ranged from 21 to 59 years with mean age of 32.38 years (SD = 8.21). Approximately 58% of participants were 30 years old or younger, and only 21% were older than 40 years, as presented in Table 3.

Table 3

*Age of Participants (N= 347)*

| Age | Frequency | Percent |
|---|---|---|
| 21-30 | 179 | 58.1 |
| 31-40 | 66 | 21.4 |
| 41-50 | 55 | 17.9 |
| 51-60 | 8 | 2.6 |
| Total | 308 | 100.0 |

**Educational level.** The majority of participants (approximately 96%) held Bachelor's degrees; 65% of them had majored in mathematics. Only eight mathematics teachers (2.4%) held Master's degree, and none of them held the Ph.D. The most common major among participants was mathematics (69%), followed by secondary education (16%), as shown in Table 4. A large number of participants graduated from colleges outside the capital city Riyadh (54%), but Riyadh Teachers College had the highest percentage of graduates (27%) among other local education schools, as displayed in Table 5.

Table 4

*Participants Sorted by their Major and Educational Level*

| | | | Teacher Educational Level | | | |
|---|---|---|---|---|---|---|
| | | | Lower than Bachelor | Bachelor | Master | Total |
| Major | Mathematics | Count | 5 | 219 | 6 | 230 |
| | | % within Major | 2.2% | 95.2% | 2.6% | 100.0% |
| | | % of Total | 1.5% | 65.4% | 1.8% | 68.7% |
| | Mathematics Education | Count | 1 | 23 | 0 | 24 |
| | | % within Major | 4.2% | 95.8% | .0% | 100.0% |
| | | % of Total | .3% | 6.9% | .0% | 7.2% |
| | Elementary Education | Count | 0 | 22 | 0 | 22 |
| | | % within Major | .0% | 100.0% | .0% | 100.0% |
| | | % of Total | .0% | 6.6% | .0% | 6.6% |
| | Secondary Education | Count | 0 | 53 | 0 | 53 |
| | | % within Major | .0% | 100.0% | .0% | 100.0% |
| | | % of Total | .0% | 15.8% | .0% | 15.8% |
| | Other | Count | 0 | 4 | 2 | 6 |
| | | % within Major | .0% | 66.7% | 33.3% | 100.0% |
| | | % of Total | .0% | 1.2% | .6% | 1.8% |
| Total | | Count | 6 | 321 | 8 | 335 |
| | | % within Major | 1.8% | 95.8% | 2.4% | 100.0% |

Table 5

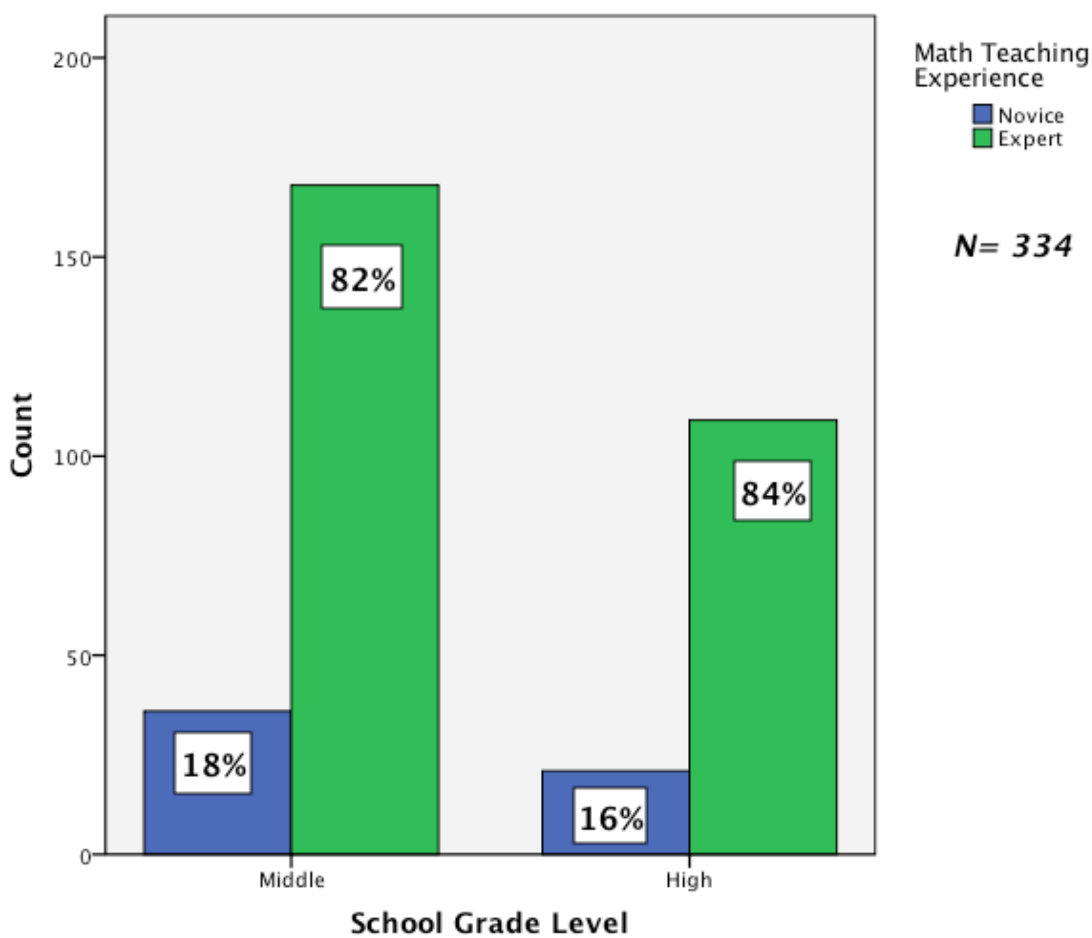
*Participants' School of Graduation*

| Teacher College | Frequency | Percent |
|---|---|---|
| Riyadh Teachers College | 88 | 26.7 |
| King Saud University | 55 | 16.7 |
| Imam Muhammad Ibn Saud University | 7 | 2.1 |
| Other | 179 | 54.4 |
| Total | 329 | 100.0 |

**Teaching experience.** The highest percentage of participants was experienced (as defined as having more than one year of teaching experience) mathematics teachers (N= 277, 83%), with 39% of them with more than five years of teaching experience. However, a large number of respondents were novice mathematics teachers (N=57, 17%) and they were comprised of 17.6% of middle schools teachers and 16.2% of high schools teachers. In addition, the majority of the experienced mathematics teachers did not teach subjects matter other than mathematics (N= 243, 88%, with 58% of them in middle schools and 42% in high schools). Figure 10 shows a summary of the overall mathematics teaching experience data.

Figure 10

*Participants' Mathematics Teaching Experience Sorted by School Grade Level*



**Teaching load.** Participants' teaching load was high, with 73% of them having more than 25 students on average in a classroom and teaching all grade levels in middle school (30%) or high school (13%). Approximately 56% of participants were teaching more than one grade level at their schools (61% middle) (48% high) and many were teaching in all grade levels (30% middle and 13% high), as presented in Table 6 and Figure 11. Furthermore, the largest percentage of participants (18%) had 30 students in their classroom (*M*=30.91, *SD*= 8.74). In addition, the most common range of average classroom size was 21 to 30 students (45%) and then 31 to 40 (33%), as displayed in Table 7. However, high schools tended to have larger classroom size (between 31 and 40 students (41%)) than middle schools (28%), as shown in Figure 12.

Table 6

*Participants' Teaching Grade Levels*

| Number of Teaching Grade Levels | Frequency | Percent |
|---|---|---|
| One Grade Level | 146 | 43.8 |
| More than One Grade Level | 187 | 56.2 |
| Total | 333 | 100.0 |

Figure 11

*Participants' School Grade Level Sorted by the Number of Teaching Grade Levels (N= 333)*

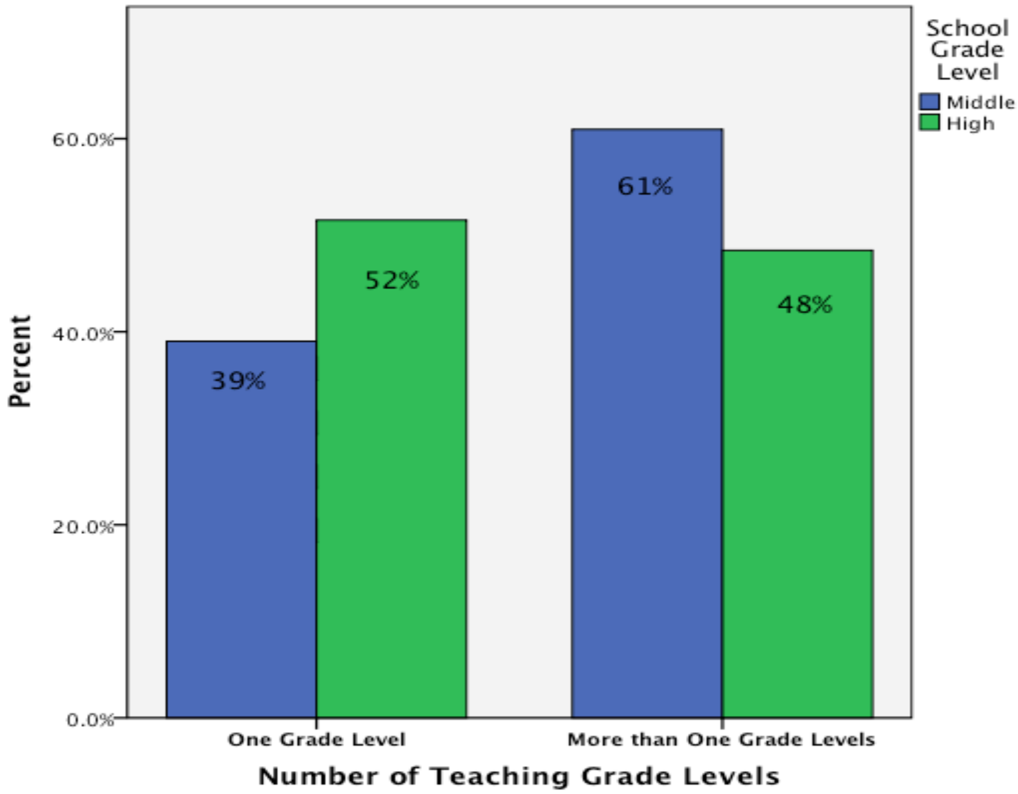


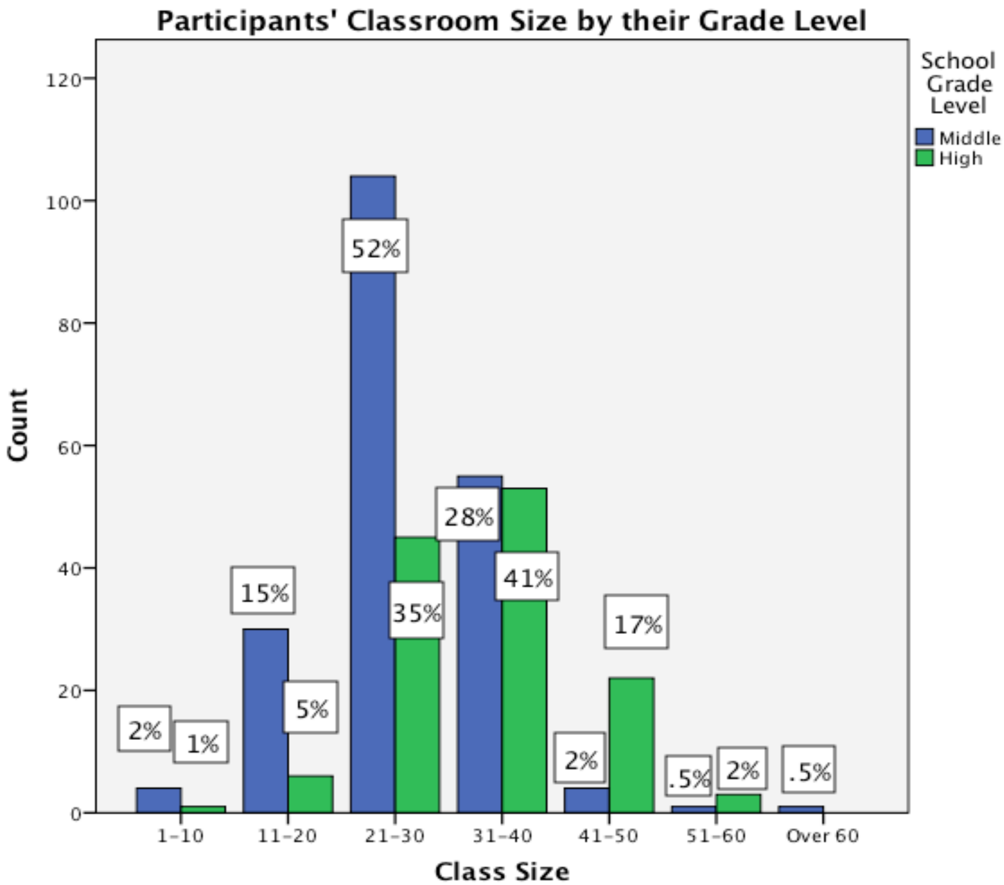

Table 7

*Participants' Classroom Size*

| Classroom Size | Frequency | Percent |
|---|---|---|
| 1-10 | 5 | 1.5 |
| 11-20 | 36 | 10.9 |
| 21-30 | 149 | 45.3 |
| 31-40 | 108 | 32.8 |
| 41-50 | 26 | 7.9 |
| 51-60 | 4 | 1.2 |
| Over 60 | 1 | .3 |
| Total | 329 | 100.0 |

Figure 12

*Participants' Class Size within each School Grade Level*




**Qiyas Teacher Aptitude test score.** Since 2007, all teachers in Saudi Arabia have been required to complete this aptitude test to be qualified to work in Saudi public schools. A lot of data (88%) was missing for this variable. The reason reported by participants was they either did not take the test or did not remember their results. Sixty-five participants shared both their major and overall scores, and 81.5% of them were considered qualified, according to the Saudi Ministry of Education standard of receiving a score of at least 50% in both the major section and the overall score.

**Email availability.** A high percentage of participants had email accounts (N=162, 62%).

Table 8

*Mathematics Teachers Email Availability*

| e-Mail | Frequency | Percent |
|---|---|---|
| Yes | 162 | 62.1 |
| No | 99 | 37.9 |
| Total | 261 | 100.0 |

**Anxiety level.** On a five-point Likert scale, mathematics teachers rated their anxiety regarding teaching mathematics and integrating technology in their teaching by responding to two statements such as " I have anxiety about teaching with technology" ranged from 1 to 5 (1 = Strongly Disagree, 2 = Disagree, 3 = Neither Agree or disagree, 4 = Agree, and 5 = Strongly Agree). Participants who reported that they did not have anxiety about teaching mathematics were 77.7% (Strongly Disagree 47.6% and Disagree 30.1%), while only 10.4% agreed or strongly agreed to having anxiety about teaching mathematics, and 11.9% selected Neither Agree or Disagree option, as shown in Table 9. For the anxiety about teaching with technology, 56.7% disagreed (28.5% Strongly Disagree and 28.2% Disagree), 17 % agreed (12.4% Agree and 4.6 Strongly Agree), and 22.8% were undecided, as shown in Table 10. These two variables about anxiety regarding teaching mathematics and integrating technology were positively correlated. The results of the correlational analyses presented in Table 11 show that participants' self-ratings of anxiety regarding teaching mathematics and using technology in their teaching were statistically significant, $r$ (333) = .58, $p < .001$. This suggests that if mathematics teachers reported themselves as having anxiety regarding teaching mathematics, they tend to state the same problem when using technology in their teaching and vice versa. No differences existed among grade levels (middle and high schools) in regard to these two variables or their relationship.

Table 9

*Teacher Anxiety with Teaching Mathematics*

| Teacher Anxiety with Teaching Mathematics | Frequency | Percent |
|---|---|---|
| Strongly Disagree | 160 | 47.6 |
| Disagree | 101 | 30.1 |
| Neither Agree or Disagree | 40 | 11.9 |
| Agree | 28 | 8.3 |
| Strongly Agree | 7 | 2.1 |
| Total | 336 | 100.0 |

Table 10

*Teacher Anxiety with Technology Integration*

| Teacher Anxiety with Technology Integration | Frequency | Percent |
|---|---|---|
| Strongly Disagree | 99 | 28.5 |
| Disagree | 98 | 28.2 |
| Neither Agree or Disagree | 79 | 22.8 |
| Agree | 43 | 12.4 |
| Strongly Agree | 16 | 4.6 |
| Total | 335 | 96.5 |

Table 11

*Pearson Correlations of Anxiety with Teaching Mathematics and Technology Integration*

| | | Teacher Anxiety with Teaching Mathematics | Teacher Anxiety with Technology Integration |
|---|---|---|---|
| Teacher Anxiety with teaching Mathematics | Pearson Correlation | 1 | .584** |
| | Sig. (2-tailed) | | .000 |
| | N | 336 | 335 |
| Teacher Anxiety with Technology | Pearson Correlation | .584** | 1 |
| | Sig. (2-tailed) | .000 | |
| | N | 335 | 335 |

**. Correlation is significant at the 0.01 level (2-tailed).

**Missing Data Analysis**

Missing data values can threaten the validity of the data analysis (internal validity) and limit the generalizability of results (external validity) (McKnight, 2007; Tabachnick & Fidell, 2007). Therefore, prevention steps were followed to control for the rate of missingness. From the design of the study until the data entry, the missing data prevention procedures were applied to avoid or reduce the missing of information. First, the pilot study helped in understanding the target population and tested the appropriateness of the research instruments (length, content, layout, and language). Second, the final draft of the research instruments included clear instructions and assurances of user-friendliness. Third, a high number of surveys (N= 1030) was distributed to decrease the likelihood of missing data. Finally, the entry of data was done by the researcher and proofread by another individual (de Leeuw, 2001; McKnight, 2007).

The amount and the pattern of missing data are important variables in choosing how to resolve problems of missingness when it exists (Tabachnick & Fidell, 2007). The data screening revealed that missing data ranged from 0.3 to 88 percent as displayed in Table 12. The missingness was high only for the Teachers Aptitude Test question in the demographic information part in the teacher survey, and the reason for not responding was failure to take the test or remember the score. In addition, the pilot study revealed that the target samples might not have taken the test, but it was decided to keep this question to measure the percentage of mathematics teachers who did take the test. Then the missing data was analyzed using PASW (SPSS) 18 to determine if the pattern of missingness was *missing completely at random* (MCAR), *missing at random* (MAR), or *missing not at random* (MNAR); which is also called *nonignorable* (R. J. A. Little & Rubin, 2002; Rubin, 1976; Tabachnick & Fidell, 2007). Little's MCAR test indicated that the data were not MCAR, and Separate Variance t-tests showed that the data were not MAR. Based on the result of this analysis, considering the amount and pattern of missing data, the decision was made to impute missing data using multiple imputation (MI) in PASW (SPSS) 18 with 100 imputations as recommended by Graham, Olchowski, and Gilreath (2007). The multiple imputation (MI) does not assume MCAR or MAR for missingness and tolerates MNAR data better than do the traditional data missing techniques (Baraldi & Enders, 2010; Schafer & Graham, 2002; Tabachnick & Fidell, 2007). The multiple imputation (MI) has three phases (imputation, analysis, and pooling). In the first step, a predetermined number of data set ($m > 1$) is created, and each set has different estimates of the missing information. Then each data set was analyzed by the same tests that were intended to be used with the complete data. Finally, the multiple sets of results combined into a single set of results (Baraldi & Enders, 2010).

Table 12

*Missingness of Variables*

| | Valid | | Missing | |
|---|---|---|---|---|
| | N | Percent | N | Percent |
| Perceived preparation (Math courses) | 319 | 92% | 28 | 8% |
| Perceived preparation (Math Ed. courses) | 315 | 91% | 32 | 9% |
| Perceived preparation (Ed. tech courses) | 313 | 90% | 34 | 10% |
| Perceived preparation (Tech courses) | 313 | 90% | 34 | 10% |
| Teachers' Average grade in Math courses | 315 | 91% | 32 | 9% |
| Teachers' Average grade in Tech courses | 307 | 88% | 40 | 12% |
| Teachers' Average grade in Math Ed. Courses | 297 | 86% | 50 | 14% |
| Teachers' Average grade in Ed. Tech | 292 | 84% | 55 | 16% |
| Perceived preparation (Math Training) | 301 | 87% | 46 | 13% |
| Perceived preparation (Math Ed. Training) | 299 | 86% | 48 | 14% |
| Perceived preparation (Ed. tech Training) | 297 | 86% | 50 | 14% |
| Perceived preparation (Tech Training) | 299 | 86% | 48 | 14% |
| Math anxiety | 336 | 97% | 11 | 3% |
| Technology anxiety | 335 | 97% | 12 | 3% |
| Grade of teaching | 333 | 96% | 14 | 4% |
| Classroom size | 329 | 95% | 18 | 5% |
| Teaching experience | 334 | 96% | 13 | 4% |
| Years of teaching Math | 334 | 96% | 13 | 4% |
| Years of teaching other subject | 334 | 96% | 13 | 4% |
| Teacher aptitude test: Ed. Part score | 56 | 16% | 291 | 84% |
| Teacher aptitude test: Lang. Part score | 58 | 17% | 289 | 83% |
| Teacher aptitude test: Numerical Part score | 43 | 12% | 304 | 88% |
| Teacher aptitude test: Major Part score | 69 | 20% | 278 | 80% |
| Teacher aptitude test: Overall score | 94 | 27% | 253 | 73% |
| Age | 308 | 89% | 39 | 11% |
| Email | 261 | 75% | 86 | 25% |

**Instruments**

The research instruments' (Teacher's and Teachers' effectiveness Surveys) validity and reliability were measured for internal consistency using Cronbach's alpha reliability technique and construct validity using principal components factor analysis with direct oblimin rotation and Kaiser normalization. The data was screened for univariate outliers and missing data. No outliers were detected, and the percentage of missing data for each item in TPACK and Teachers' effectiveness scales was less than 3%. The multiple imputations were employed to deal with missing data.

**Reliability.** The internal consistency was evaluated by Cronbach's alpha analysis. The alpha reliability coefficients for teachers TPACK scale was .937 and .934 for teacher effectiveness scale. The Cronbach's alpha for TK, CK, PK, PCK, TCK, TPK, and TPACK subscales were .727, .716, .761, .838, .775, .813, and .841, respectively. These alpha values were in the range of acceptance level (DeVellis, 2003; George & Mallery, 2011; Nunnally, 1978).

**Construct validity.** The dimensionality of the 28-item TPACK and the dimensionality of the 14-item teacher effectiveness scales were analyzed using principal components analysis (PCA) with direct oblimin rotation. Two criteria were used to determine the number of components: Kaiser-Guttman rule of Eigen values greater than 1 for accepted factor (Guttman, 1954; Kaiser, 1960), and Cattell's (1966) scree plot test. PCA with direct oblimin was used because there is the assumption that the variables are not orthogonal and are in fact correlated. PCA was used to extract factors (reduce the number of variables) and detect the structure of the relationship of the variables. Also, the oblimin rotation was used instead of the oblique rotation because it allows for correlation of the variables and variables may span more than one factor.

The variance accounted for by the solution, the variance accounted for by each individual factor, and the interpretability of the factors were all evaluated to determine the initial plausibility of the factor structure.

***TPACK scale.*** The appropriateness of the data for factor analysis was tested first by the correlation matrix, the Kaiser-Meyer-Olkin statistic (Kaiser, 1974) and the Bartlett's test of Sphericity (Bartlett, 1954). The subscales of TK, CK, PK, PCK, TCK, TPK, TPACK yielded coefficients of .2 and above. The Kaiser-Meyer-Olkin values (KMO) of TK, CK, PK, PCK, TCK, TPK, TPACK subscales exceeded the minimum suggested value of .60 with .723, .72, .757, .804, .747, .734, and .804 respectively (Kaiser, 1974). The Bartlett's test was statistically significant for each subscale, and the factorability of the correlation matrices was supported.

Principal components analysis (PCA) with direct oblimin rotation revealed the presence of one component for each subscales with eigenvalues exceeding 1. The single-factor structures of TK, CK, PK, PCK, TCK, TPK, and TPACK subscales accounted for 55%, 59%, 59%, 67%, 62%, 65% and 67% of the total variance respectively. Also, these results were supported by the scree plot analyses that each subscales only measured one construct.

***Teacher effectiveness scale.*** This scale had an appropriate data for factor analysis with coefficients of .3 and above in the correlation matrix, KMO value of .937 and a significant result on Bartlett's test. Therefore, the factorability of the correlation matrix was supported.

Principal components analysis (PCA) with direct oblimin rotation revealed the presence of two components with eigenvalues exceeding 1, explaining 55.69% and 8.39% of the total variance respectively. However, one-component solution explained the majority of the variance and had the highest loadings. Also, this result supported by the scree plot analyses that showed one construct should be retained.

**Principal Evaluation of Teacher Effectiveness**

Saudi Arabian middle and high public school principals in Riyadh were asked to evaluate their mathematics teachers' effectiveness by responding to a survey that consisted of 14 items. School administrators were given a scale of five rating levels (Lower 20%, Lower 50%, Upper 50%, Upper 25%, Upper 10%) to measure their mathematics teachers' effectiveness in comparison to other mathematics teachers with whom they have worked.

The result of this survey is summarized in Table 13 for each item. Principals tended, slightly, to rate their mathematics teachers at high level, with an average of 3.11 and a 10-90 percentile range from 1 to 4. Principals rated significantly their mathematics teachers to be most effective at their abilities to work with supervisors and peer with M = 3.20; however, they believed that their mathematics teachers are less effective at their use of technology (M=2.84, SD= 1.06), $F(13, 4355) = 9.6$, $p < .01$. A high percentage (60%) of principals (n=109) rated their mathematics teachers from average (Upper 50%) to highly effective (Upper 10%) on the overall scale, and approximately 23% of their mathematics teachers evaluated at the upper 50% level. However, the normality of the distribution is still assumed since the impact of the positive kurtosis is decreased with the large sample size (N=347), as displayed in Figure 13 and 14 and Table 14 (Tabachnick & Fidell, 2007).

A bivariate correlation coefficient test found weak to strong positive relationship between the 14 items in the teachers' effectiveness scale (Cohen, 1988; Salkind, 2012), as shown in Table 15. Using the Bonferroni approach to control for Type I error across the 91 correlations, a $p$ value of less than .0005 was required for significance. The results of the correlational analyses show that all 91 correlations were statistically significant and were greater than or equal to .29.

Table 13

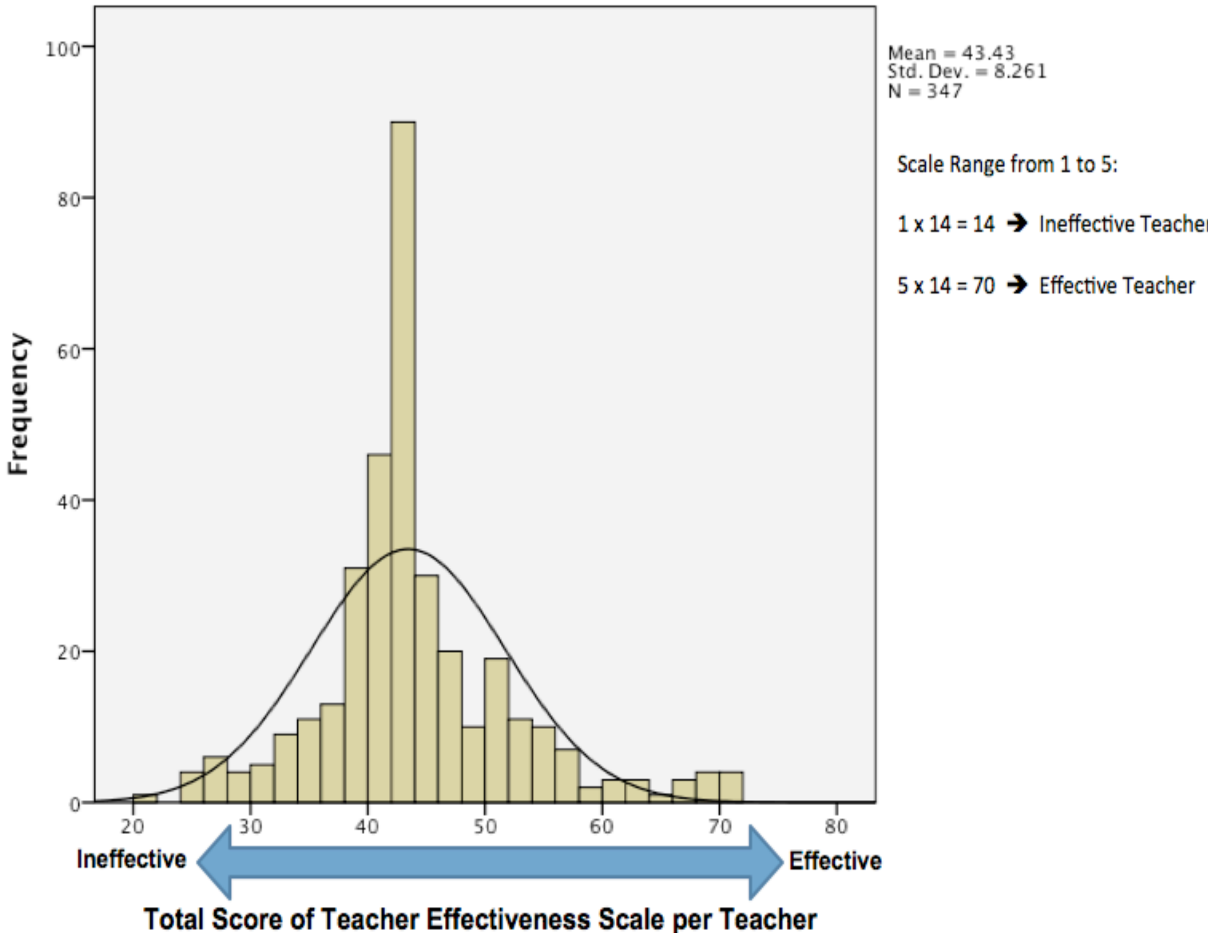
*Principal Evaluation of Teachers' Effectiveness (N=347)*

| Item | Mean (SD) | 10th Percentile | 90th Percentile |
|---|---|---|---|
| Teaching Methods | 3.08 (.77) | 2 | 4 |
| Knowledge of the content he teaches | 3.16 (.71) | 2 | 4 |
| **Effective use of technology** | **2.84 (1.06)** | 1 | 4 |
| Initiative | 3.09 (.84) | 2 | 4 |
| Creativity | 2.98 (.95) | 2 | 4 |
| Enthusiasm | 3.10 (.83) | 2 | 4 |
| **Ability to work with supervisors** | **3.20 (.70)** | 3 | 4 |
| **Ability to work with peers** | **3.20 (.66)** | 3 | 4 |
| Rapport with parents | 3.16 (.69) | 3 | 3 |
| Rapport with pupils | 3.11 (.73) | 2 | 4 |
| Classroom planning | 3.14 (.86) | 2 | 4 |
| Ability to maintain discipline | 3.17 (.76) | 2 | 4 |
| Willingness to improve professionally | 3.18 (.85) | 2 | 4 |
| Overall teaching success | 3.13 (.67) | 3 | 4 |

Scale: 1= Lower 20%, 2 = Lower 50%, 3= Upper 50%, 4 = Upper 25%, 5 = Upper 10%.

Figure 13

*Graphical Normality Test for Principals' Ratings of Teacher Effectiveness I*



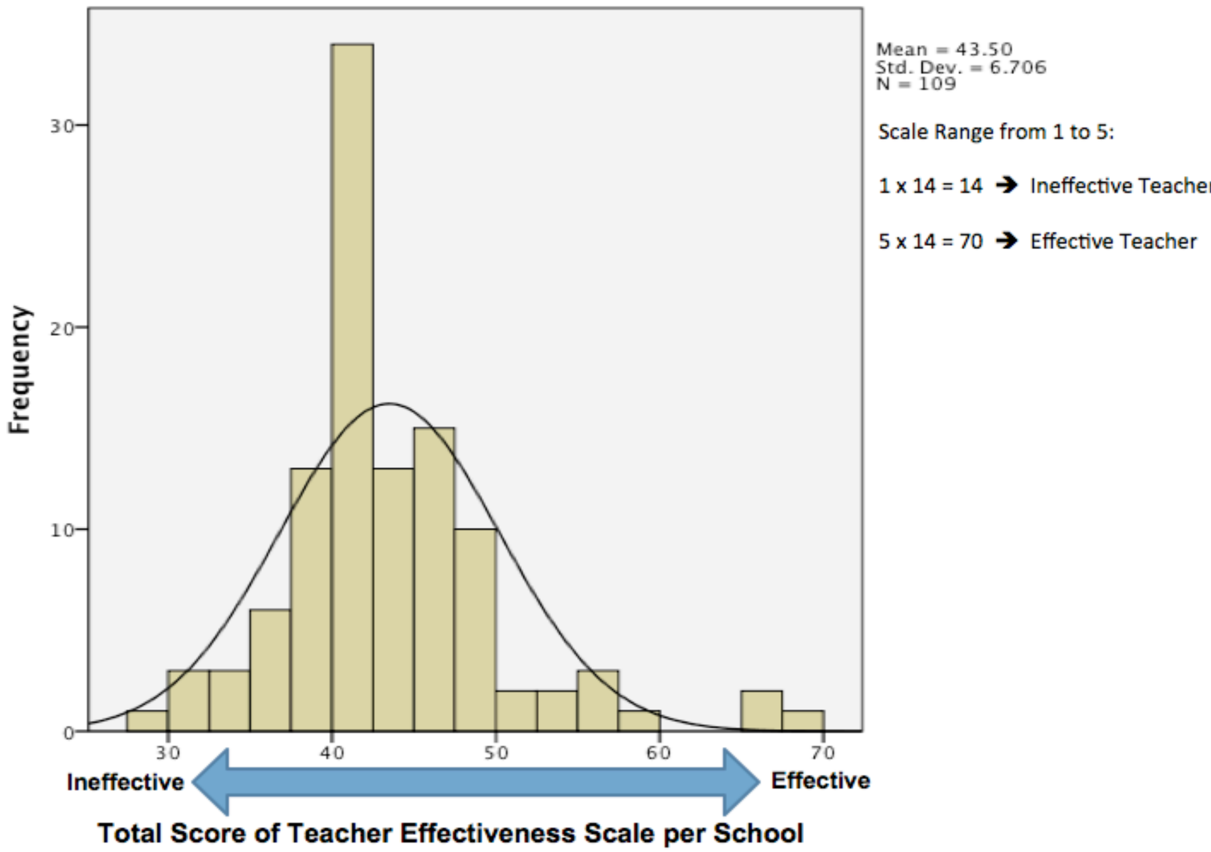



Table 14

*Numerical Normality Test for Principals' Ratings of Teacher Effectiveness*

| | Sum of 14 TE item scores |
|---|---|
| N | 347 |
| Mean | 43.4323 |
| Std. Deviation | 8.26147 |
| Skewness | .755 |
| Std. Error of Skewness | .131 |
| Kurtosis | 1.773 |
| Std. Error of Kurtosis | .261 |

Figure 14

*Graphical Normality Test for Principals' Ratings of Teacher Effectiveness II*

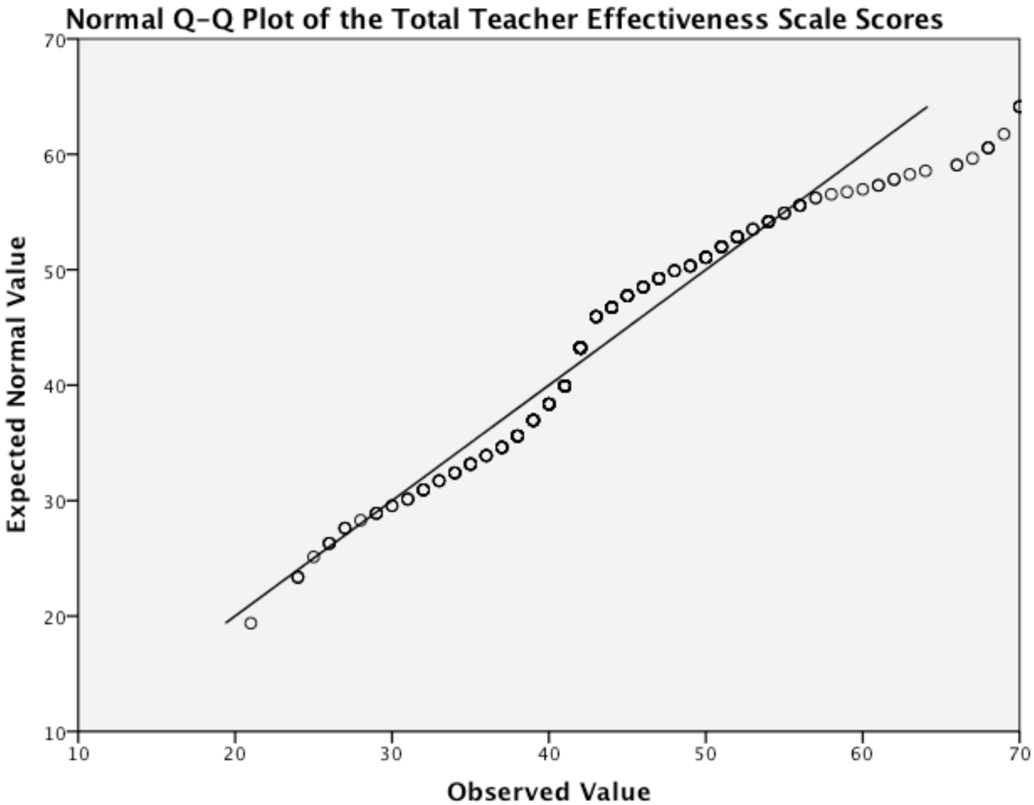



Table 15

*Correlations among the Fourteen Items of Teacher Effectiveness Scale (N = 347)*

| | TE 1 | TE 2 | TE 3 | TE 4 | TE 5 | TE 6 | TE 7 | TE 8 | TE 9 | TE10 | TE 11 | TE 12 | TE 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TE2 | .576* | | | | | | | | | | | | |
| TE 3 | .374* | .383* | | | | | | | | | | | |
| TE 4 | .462* | .466* | .532* | | | | | | | | | | |
| TE 5 | .476* | .477* | .583* | .691* | | | | | | | | | |
| TE 6 | .604* | .520* | .490* | .645* | .585* | | | | | | | | |
| TE 7 | .499* | .592* | .373* | .525* | .516* | .595* | | | | | | | |
| TE 8 | .491* | .618* | .293* | .466* | .429* | .538* | .736* | | | | | | |
| TE 9 | .491* | .549* | .331* | .515* | .478* | .546* | .676* | .668* | | | | | |
| TE 10 | .512* | .506* | .306* | .411* | .405* | .496* | .539* | .598* | .721* | | | | |
| TE 11 | .534* | .514* | .449* | .519* | .532* | .556* | .552* | .499* | .448* | .491* | | | |
| TE 12 | .451* | .551* | .361* | .496* | .455* | .553* | .622* | .581* | .541* | .518* | .560* | | |
| TE 13 | .448* | .513* | .336* | .473* | .428* | .535* | .591* | .492* | .446* | .405* | .513* | .605* | |
| TE 14 | .619* | .578* | .410* | .502* | .500* | .637* | .607* | .659* | .554* | .566* | .560* | .688* | .601* |

* *p* < .0005

**Hypotheses Testing**

*H1. Saudi Arabian 7-12 mathematics teachers rate themselves high on the knowledge of technology, pedagogy, and mathematics content and the intersections between these three domains of knowledge*.

To examine this hypothesis, mathematics teachers' knowledge domain and subdomains of technology, pedagogy, and mathematics content was measured by TPACK scale (28 items) that asked participants to rate their level of agreement with four statements per seven subscales (TK, CK, PK, PCK, TCK, TPK, TPACK) on a five-point Likert scale: (1) strongly disagree; (2) disagree; (3) neither agree or disagree, (4) agree; and (5) strongly agree. Descriptive statistics (means, frequencies, and standard deviations) showed that the percentage of participants who perceived themselves as having competence for the knowledge domain and subdomains of mathematics content, pedagogy, and technology was high, as displayed in Table 16.

Table 16

*Perceived Expertise with Mathematics Content, Pedagogy and Digital Technologies Knowledge (TPACK) (N=347)*

| Technological Pedagogical Content Knowledge (TPACK) Scale | | Mean (SD) | % Strongly Agree |
|---|---|---|---|
| **Technological Knowledge** | | | |
| 1 | I know how to use different digital technologies. | 3.75 (.84) | 12.1 |
| 2 | I know how to solve my own technical problems with digital technologies. | 3.69 (.93) | 13.0 |
| 3 | I frequently play around with digital technologies. | 3.51 (1.00) | 13.1 |
| 4 | I keep up with important new digital technologies. | 3.55 (.99) | 13.9 |
| **Average Mean** | | 3.62 (.70) | |
| **Content Knowledge** | | | |
| 5 | I reason mathematically when I solve problems in my daily life. | 2.86 (1.15) | 7.3 |
| 6 | I can make mathematical connections with the problems outside of mathematics. | 4.01 (.79) | 24.3 |
| 7 | I am able to communicate mathematically. | 4.03 (.74) | 25.1 |
| 8 | I use multiple mathematical representations when I solve problems. | 3.96 (.84) | 22.8 |
| **Average Mean** | | 3.71 (.67) | |
| **Pedagogical Knowledge** | | | |
| 9 | I know how to adapt lessons to improve student learning. | 4.20 (.67) | 30.2 |
| 10 | I know how to implement a wide range of instructional approaches. | 4.15 (.69) | 30.3 |
| 11 | I know how to organize a classroom environment for learning. | 3.87 (.84) | 19.8 |
| 12 | I know how to assess student performance in a classroom. | 4.21 (.68) | 32.7 |
| **Average Mean** | | 4.11 (.55) | |
| **Pedagogical Content Knowledge** | | | |
| 13 | I have a good understanding of teaching mathematics so that students are able to learn. | 3.98 (.76) | 22.4 |
| 14 | I have a good understanding of instructional strategies that best represent mathematical topics. | 4.02 (.72) | 22.7 |
| 15 | I have a good understanding of students' conceptual and practical understanding of mathematical concepts. | 3.95 (.72) | 19.4 |
| 16 | I have a good understanding of the mathematics curriculum that meets students' needs for learning mathematics. | 3.91 (.72) | 16.9 |

| | | | |
|---|---|---|---|
| **Average Mean** | | 3.96 (.60) | |
| **Technological Content Knowledge** | | | |
| 17 | I know how to use digital technologies to represent mathematical ideas. | 3.64 (.88) | 12.4 |
| 18 | I am able to select certain digital technologies to communicate mathematical processes. | 3.66 (.89) | 12.4 |
| 19 | I am able to use digital technologies to solve mathematics problems. | 3.55 (.93) | 9.8 |
| 20 | I am able to use digital technologies to explore mathematical ideas. | 3.93 (.90) | 24.9 |
| **Average Mean** | | 3.69 (.69) | |
| **Technological Pedagogical Knowledge** | | | |
| 21 | I am able to identify digital technologies to enhance the teaching approaches for a lesson. | 3.59 (.90) | 10.7 |
| 22 | I can implement specific digital technologies to support students' learning for a lesson. | 3.68 (.87) | 12.0 |
| 23 | I think deeply about how digital technologies influence teaching approaches I use in my classroom. | 3.37 (1.07) | 12.4 |
| 24 | I can adapt digital technologies to support learning in my classroom. | 3.70 (.86) | 13.3 |
| **Average Mean** | | 3.58 (.74) | |
| **Technological Pedagogical Content Knowledge** | | | |
| 25 | I know specific topics in mathematics are better learned when taught through an integration of digital technologies with my instructional approaches. | 3.74 (.83) | 13.5 |
| 26 | I can identify specific topics in the mathematics curriculum where specific digital technologies are helpful in guiding student learning in the classroom. | 3.51 (.97) | 13.3 |
| 27 | I can use strategies that combine mathematical content, digital technologies and teaching approaches to support students' understandings and thinking as they are learning mathematics. | 3.75 (.83) | 14.5 |
| 28 | I can select digital technologies to use with specific instructional strategies as I guide students in learning mathematics. | 3.74 (.84) | 15.0 |
| **Average Mean** | | 3.69 (.71) | |
| **Average Mean for the Whole Scale** | | 3.77 (.52) | |

However, mathematics teachers rated their knowledge significantly higher in the pedagogical knowledge (PK) domain (M = 4.11, SD = 0.55) than other domains and subdomain, $F(6, 2070) = 61.78$, $p < .01$. A bivariate correlation coefficient test found weak to strong positive relationship between knowledge domains and subdomains (Cohen, 1988; Salkind, 2012), as shown in Table 17. Using the Bonferroni approach to control for Type I error across the 21 correlations, a *p* value of less than .002 was required for significance. The results of the correlational analyses show that all 21 correlations were statistically significant and were greater than or equal to .27. In addition, the relationships between the subdomains of TCK, TPK, and TPACK were strong, which suggests that if mathematics teachers perceived themselves as mastering the knowledge in one subdomain of technology, they tend to state that they master the other two.

Table 17

*Correlations among the Seven Domains and Subdomains of Knowledge (N = 347)*

| | TK | CK | PK | PCK | TCK | TPK |
|---|---|---|---|---|---|---|
| CK | .521* | | | | | |
| PK | .274* | .595* | | | | |
| PCK | .332* | .636* | .726* | | | |
| TCK | .572* | .593* | .476* | .548* | | |
| TPK | .519* | .532* | .485* | .537* | .771* | |
| TPACK | .462* | .497* | .402* | .508* | .716* | .714* |

* $p < .002$

A MANOVA comparing the means of school grade levels, teaching experience, school of graduation, educational level (lower than BA, BA, MS, and Ph.D.), major, and age for each domain and subdomain of knowledge measured by TPACK scale was calculated. Only educational level, teaching experience (novice and expert), and age (young and old) categorical variables were determining factors in mathematics teachers' perceived knowledge of content, pedagogy, and digital technologies. However, their multivariate $\eta^2$ based on Wilks's $\Lambda$ were quite weak .04, .07, and .04 for educational levels, age, and teaching experience respectively.

The cell sizes for groups were unequal and small, especially for educational levels and teaching experience, and that might suppress their effects.

*H2. There is a statistically significant linear relationship between mathematics teachers' self-perceived knowledge in technology, pedagogy, and mathematics content and their teaching effectiveness.*

Correlation coefficients were computed among mathematics teachers' perceived knowledge domains and subdomains (TK, CK, PK, PCK, TCK, TPK, TPACK) and principals' ratings of teacher effectiveness. Using the Bonferroni approach to control for Type I error across the 28 correlations, a $p$ value of less than .001 (.05/36 = .001) was required for significance. Pearson correlation coefficient was used to test this hypothesis and found no statistically significant linear relationship between these variables as presented in Table 18.

Table 18

*Correlation of Knowledge Domains and Subdomains to Teacher Effectiveness per Teacher (N=347)*

| Knowledge Domains and Subdomains | Principal Ratings of Teacher Effectiveness | |
|---|---|---|
| | Pearson Correlation | Significance |
| Technology Knowledge (TK) | .089 | .101 |
| Content Knowledge (CK) | -.093 | .085 |
| Pedagogical Knowledge (PK) | -.007 | .890 |
| Pedagogical Content Knowledge (PCK) | -.040 | .458 |
| Technological Content Knowledge (TCK) | .001 | .987 |
| Technological Pedagogical Knowledge (TPK) | -.018 | .738 |
| Technological Pedagogical Content Knowledge (TPACK) | -.018 | .733 |
| Whole Scale of TPACK | -.015 | .786 |

* * $p < .002$

However, when correlation coefficients were computed between the criterion variable (teacher effectiveness) and the predictor variables (mathematics teachers' self-perceived knowledge of content, pedagogy, and technology variables) between schools, there was a negative correlation relationship between content knowledge (CK) and principal ratings of teacher effectiveness. In fact, this correlation coefficient was significant at *p* level of .05 but it was weak, as displayed in Table 19 and Figure 15.

Table 19

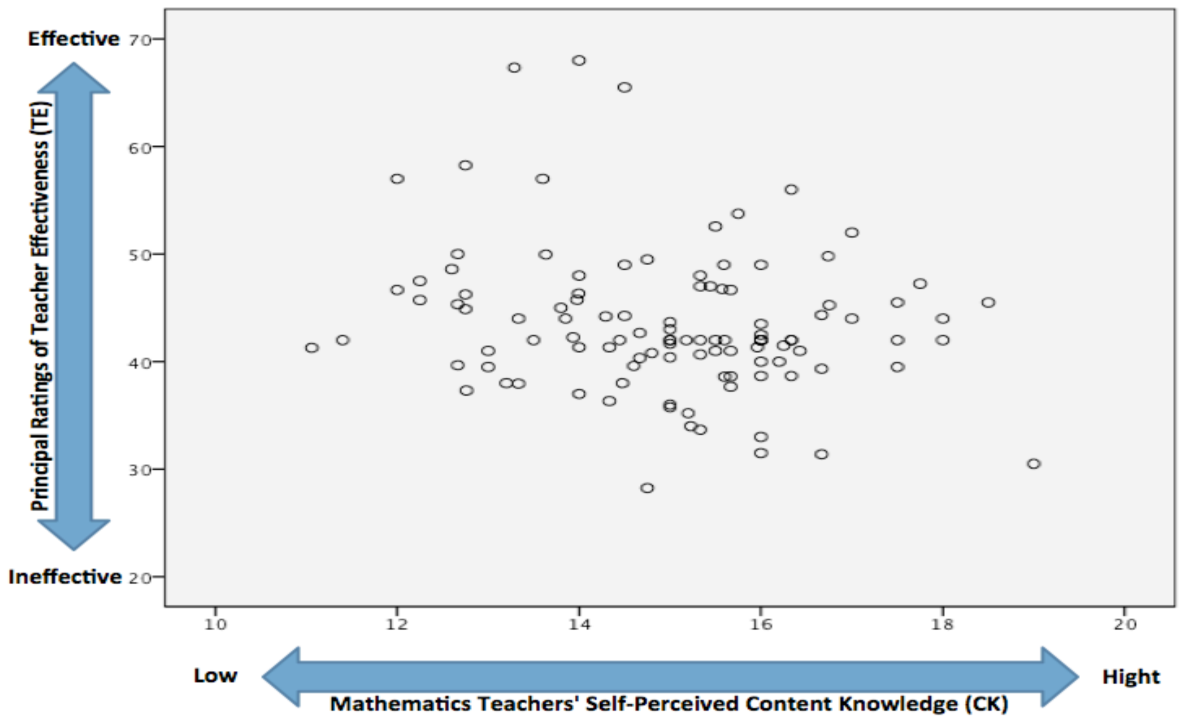
*Correlation of Knowledge Domains and Subdomains to Teacher Effectiveness per School (N=109)*

| Knowledge Domains and Subdomains | Principal Ratings of Teacher Effectiveness | |
|---|---|---|
| | Pearson Correlation | Significance |
| Technology Knowledge (TK) | .013 | .896 |
| Content Knowledge (CK) | **-.213*** | **.026** |
| Pedagogical Knowledge (PK) | -.094 | .334 |
| Pedagogical Content Knowledge (PCK) | -.131 | .174 |
| Technological Content Knowledge (TCK) | -.112 | .245 |
| Technological Pedagogical Knowledge (TPK) | -.114 | .240 |
| Technological Pedagogical Content Knowledge (TPACK) | -.155 | .107 |
| Whole Scale of TPACK | -.150 | .119 |

* * $p < .002$

Figure 15

*Correlation of Content Knowledge (CK) to Teacher Effectiveness between Schools*




*H3. Saudi Arabian 7-12 mathematics teachers rate their level of preparation at high in integrating digital technologies in teaching mathematics.*

To examine this hypothesis, mathematics teachers' perceptions of their teacher education programs and professional training were measured by five questions in part two in teachers' questionnaire. Participants reported how many courses they have taken in their teacher education programs and training hours they have attended in their current school year. They also estimated their average course grade in each content area (mathematics, mathematics education, technology, and educational technology). On a five-point Likert scale [(1) strongly disagree; (2) disagree; (3) neither agree or disagree, (4) agree; and (5) strongly agree], participants rated their level of agreement with the statement that teacher education courses and professional training workshops were effective in preparing them to integrate digital technologies in their teaching.

Descriptive statistics (means, frequencies, and standard deviations) showed a high level of teachers' satisfaction with their teacher education programs and a low one with their professional training programs. Participants completed, on average, 33 math courses (SD = 10.27), 12 mathematics educational methods courses (SD = 4), four educational technology courses (SD = 2), and two technology courses (SD = 1). They estimated their average grade in those courses to be ranged between B and $B^+$, on average. Participants attended very limited hours of professional development during their current school year. On average, they received four hours of training in mathematics content, two hours in educational technology and one hour in mathematics education and technology. However, high percentages of mathematics teachers did not join any professional training or workshops in mathematics content (64.6%), mathematics education (73.8%), educational technology (81.8%), technology (82.7%), or other areas (93.3%).

As indicated in Table 20, participants, on average, rated their preparation by teacher education course to integrate technology in their teaching of mathematics at high level. However, they were unhappy, on average, with their professional development programs in preparing them to integrate digital technologies in their mathematics teaching. They reported that their university courses prepared them to integrate digital technologies ($M=3.51$, $SD=.88$) better than professional development workshop and training ($M=3.07$, $SD=1.7$); $t(346)= 8.17$, $p<.01$.

Table 20

*Teachers' Ratings for their Readiness to Integrate Digital Technologies in their Mathematics Teaching (N=347)*

| **Teachers' Ratings** | | **Mean (SD)** | **% Strongly Agree** |
|---|---|---|---|
| **Teacher Education Courses** | | | |
| 1 | Mathematics | 3.61 (1.07) | 15.4 |
| 2 | Mathematics Educational Methods | 3.48 (1.06) | 13.7 |
| 3 | Educational Technology | 3.54 (1.04) | 13.0 |
| 4 | Technology | 3.42 (1.10) | 12.5 |
| **Average Mean** | | 3.51 (.88) | |
| **Professional Development Programs** | | | |
| 1 | Mathematics | 3.14 (1.16) | 8.0 |
| 2 | Mathematics Educational Methods | 3.03 (1.15) | 6.7 |
| 3 | Educational Technology | 3.13 (1.17) | 9.4 |
| 4 | Technology | 3.01 (1.17) | 8.4 |
| **Average Mean** | | 3.09 (1.07) | |

*H4. There is a statistically significant linear relationship between teacher effectiveness and preparation level to integrate digital technologies in teaching mathematics.*

Bivariate correlations were calculated between principals' ratings of teacher effectiveness and teachers' ratings of their preparation level to integrate digital technologies in teaching mathematics. The results of the correlational analyses presented in Table 21 show that both mathematics teachers' ratings of their teacher education and professional training programs are negatively correlated with principals' ratings of teacher quality. Both correlations were statistically significant but weak. However, the number and average grade of courses and the amount of training hours mathematics teachers have received were not factors in explaining the variance in principal rating of teacher effectiveness.

Table 21

*Correlation of Principals' Ratings of Teacher Effectiveness and Teachers' Ratings of their Preparation (N=347)*

| **Teachers' Ratings** | Principal Ratings of Teacher Effectiveness | |
|---|---|---|
| | Pearson Correlation | Significance |
| Teacher Education Courses | -.125 | .02 |
| Professional Development Programs | -.129 | .02 |

In addition, a two-way ANOVA test was conducted to evaluate the effects of receiving training (yes or no) in each content area (mathematics, mathematics education, educational technology, and technology) on principals' ratings of teacher effectiveness for each grade level (middle and high school), teaching experiences (novice and expert), school of graduation, educational level, major, and age (young and old). The results showed that teaching experience, school of graduation, major, educational levels, and age variables did not explain the variance of principals' ratings of teacher effectiveness across all professional training programs. However, there were statistically significant differences in the means on change in principals' ratings of teacher effectiveness between grade levels across receiving professional training in mathematics and mathematics education. However, the effect size values, as measured by eta-squared ($\eta^2$), indicated that the variable of grade level only explained one to two percent of the variance of teacher effectiveness rates in both professional training programs.

*H5. There is a statistically significant linear relationship between the perceived knowledge and preparation level of Saudi Arabian 7-12 mathematics teachers with respect to digital technologies integration.*

Bivariate correlations were calculated between teachers' self-evaluation of their knowledge domains and subdomains and teachers' ratings of their preparation level to integrate digital technologies in teaching mathematics. Using the Bonferroni approach to control for Type I error across the 16 correlations, a *p* value of less than .003 was required for significance. The results of the correlational analyses show that 12 out of the 16 correlations were statistically significant and were greater than or equal to .18. In fact, mathematics teachers' ratings for the impact of teacher education courses on their digital technologies integration can explain 35 percent of variation in their total TPACK scale scores, whereas their ratings for the impact of professional development programs can only explain 30 percent.

The results of the correlational analyses presented in Table 22 show that mathematics teachers' ratings for their teacher education and professional training programs were positively correlated with teachers' ratings of their knowledge of mathematics content, pedagogy, and technology. In addition, the correlations of teachers' estimations for their average grades in content areas (mathematics, mathematics education, educational technology, and technology) were statistically significant with teachers' knowledge domains and subdomains and ranged from .242 to .383.

In general, the results suggest that if mathematics teachers feel well prepared to integrate technology in their teaching, they tend to rate high their knowledge of mathematics content, pedagogy, and technology.

Table 22

*Correlation of Knowledge Domains and Subdomains to Teacher Self-evaluation of Preparation (N=347)*

| Knowledge Domains and Subdomains | Teachers Ratings | |
|---|---|---|
| | Teacher Education Courses | Professional Development Programs |
| TK | .156 | .119 |
| CK | .221* | .251* |
| PK | .187* | .149 |
| PCK | .184* | .170 |
| TCK | .347* | .285* |
| TPK | .415* | .355* |
| TPACK | .374* | .304* |
| Whole Scale of TPACK | .351* | .304* |

* $p < .003$

A MANOVA comparing the means of receiving professional training in content areas (mathematics, mathematics education, educational technology, and technology) for each domain and subdomain of knowledge measured by TPACK scale was calculated. Only attending mathematics professional training was a determining factor in mathematics teachers' perceived knowledge of content, pedagogy, and digital technologies. However, its multivariate $\eta^2$ based on Wilks's $\Lambda$ was quite weak, .055. The cell size for groups was unequal and that might suppress their effects.

*H6. There is a statistically significant relationship between mathematics teachers' demographic variables (age, level of education, number of teaching grade level, classroom size, major, school of graduation, teachers' aptitude test scores, years of teaching mathematics, years of teaching other subject matter, and teaching experience) and their teaching effectiveness.*

Pearson correlation coefficient analysis was conducted to test this hypothesis. The results showed that none of mathematics teachers' demographic variables was a significant predicator of the variance in principal ratings of teacher effectiveness, as displayed in Table 23. In other words, principals' ratings for teachers' quality were not significantly different among mathematics teachers according to their demographic information (age, level of education, number of teaching grade level, classroom size, major, school of graduation, teachers' aptitude test scores, years of teaching mathematics, years of teaching other subject matter, and teaching experience).

Table 23

*Correlation of Demographic Information with Principal Ratings of Teacher Effectiveness (N=347)*

| Demographic Information | Principal Ratings of Teacher Effectiveness | |
|---|---|---|
| | Pearson Correlation | Significance |
| Age | -.071 | .189 |
| Level of Education | .012 | .974 |
| Number of Teaching Grade Level | -.006 | .920 |
| Classroom Size | -.015 | .781 |
| Major | .012 | .828 |
| School of Graduation | .047 | .388 |
| Aptitude Test: Educational Part Score | -.035 | .552 |
| Aptitude Test: Language Part Score | -.077 | .204 |
| Aptitude Test: Numerical Part Score | -.033 | .611 |
| Aptitude Test: Major Part Score | -.028 | .635 |
| Aptitude Test: Overall Score Part | -.028 | .711 |
| Teaching Experience | -.044 | .417 |
| Years of Teaching Mathematics | -.048 | .374 |
| Years of Teaching Other Subject Matter | .022 | .681 |

Principal Rating Scale: 1= Lower 20%, 2 = Lower 50%, 3= Upper 50%, 4 = Upper 25%, 5 = Upper 10%.
* $p < .05$

*H7. There is a statistically significant relationship between the level of anxiety with teaching mathematics and teacher effectiveness.*

*H8. There is a statistically significant relationship between the level of anxiety with teaching with technology and teacher effectiveness.*

Pearson correlation coefficient was employed to examine these two hypotheses. The correlations of anxiety with teaching mathematics and using technology in teaching with principals' ratings of teacher effectiveness tended to be low and not significant, as shown in Table 24. These results suggest that both variables of anxiety regarding teaching mathematics and teaching with technology are not factors in explaining the variance in principal ratings of teacher effectiveness.

Table 24

*Correlation of Anxiety (Teaching Mathematics & Using Technology) with Principal Ratings of Teacher Effectiveness (N=347)*

| Teacher Anxiety | Principal Ratings of Teacher Effectiveness | |
|---|---|---|
| | Pearson Correlation | Significance |
| Anxiety with Teaching Mathematics | -.040 | .462 |
| Anxiety with Teaching with Technology | -.034 | .535 |

* $p < .02$

**Summary**

This chapter presented the results of analyzing the data of teacher and principal surveys. These results showed incongruence between teachers and their principals regarding the quality of mathematics teaching and the effectiveness of technology integration. Negative or no relationship was found between teachers' and principals' perceptions about the influence of mathematics teachers' knowledge in content, pedagogy, and technology on their teaching effectiveness.

# CHAPTER V

# DISCUSSION

## Introduction

Interpreting the study findings and placing them in the context of the hypotheses and the literature as well as examining implications and limitations are very important elements of dissertations and motivate readers (Cone & Foster, 2006; Foss & Waters, 2007). This chapter, therefore, provides a summary of the study, interpretation of findings, implications, limitations of the study and suggestions for future research.

## Summary of the Study

The purpose of this study was to investigate how middle and high school Saudi Arabian mathematics teachers self-evaluate their knowledge in technology, pedagogy, and mathematics content (TPACK) and how it is related to their mathematics teaching effectiveness. A descriptive correlational research design was used, and a convenience sample of 347 mathematics teachers was polled (214 middle school teachers and 133 high school teachers). Teachers' knowledge of technology, pedagogy, and mathematics content was measured by a self-evaluation questionnaire, and teacher effectiveness was measured by principals' ratings of teachers. Saudi Arabian mathematics teachers rated high their knowledge domains and subdomains of technology, pedagogy, and mathematics content (TPACK) and were most confident in their pedagogy knowledge (PK). In addition, they tended to rate their competency at the same level across the subdomains of technology (TCK, TPK, and TPACK). Their self-reports of knowledge domains and subdomains were not largely different among participants according to their demographic variables (e.g., educational levels, teaching experience, age). Saudi mathematics teachers were happy with their teacher education programs in preparing them to integrate digital technologies in their mathematics teaching, whereas they were discontent with their professional training programs' preparation of them for seamless digital technologies integration into their mathematics teaching. Also, their self-perceived knowledge in technology, pedagogy, and mathematics content had a positive relationship with their preparation level to integrate digital technologies in their mathematics teaching. Mathematics teachers received few hours of training during their current school year, and a large percentage of them did not receive any training in technology and educational technology. Principals rated slightly high the effectiveness of their mathematics teachers; however, no relationship was found between teacher effectiveness and mathematics teachers' technological pedagogical content knowledge (TPACK). In addition, there were significant negative relationships between teacher effectiveness and teacher preparation level. Demographic information and anxiety regarding teaching mathematics or teaching with digital technologies had no significant relationship with teacher effectiveness.

**Hypotheses Findings and Discussion**

*H1. Saudi Arabian 7-12 mathematics teachers rate themselves high on the knowledge of technology, pedagogy, and mathematics content and the intersections between these three domains of knowledge.*

Saudi mathematics teacher had high TPACK self-efficacy, inasmuch as a high percentage of them perceived themselves as having competence for the knowledge domain and subdomains of technology, pedagogy, and mathematics content. However, they felt more confident in their pedagogy knowledge, and this could be related to having more than five years of teaching experience (N= 169, 51%) and/or the emphasis the Saudi public school system places on such knowledge domain. Polly (2011) found in his case study that experienced mathematics teachers had higher confidence in both their content knowledge (CK) and pedagogical content knowledge (PCK) when compared to other knowledge domains.

In addition, they are likely to perceive themselves as mastering the knowledge in all the subdomains of TCK, TPK, and TPACK when they stated that they mastered one of them, and this was consistent with what Hervey (2011) found. This finding shows only how mathematics teachers are confident in their technological pedagogical content knowledge (TPACK), and it does not guarantee (because of the validity threats of the subjectivity of the self-evaluation measurement tool and the inexperience of teachers) whether they mastered the TPACK (Hervey, 2011; Kimberly A. Lawless & Pellegrino, 2007; Lyublinskaya & Tournaki, 2012; Tee & Lee, 2011). However, it attests to their willingness to integrate digital technologies in their mathematics teaching (Abbitt, 2011) and confirms that they are at least at the accepting level of TPACK development model (Niess et al., 2009). Their self-evaluations for the knowledge of technology, pedagogy, and mathematics content were not different among their demographic categories except for a slight effect related to their educational level, teaching experience (novice and expert), and age (young and old), which is consistent with what researchers found about the impact of age (Valtonen et al., 2011) and teaching experience (M. H. Lee & Tsai, 2010). This indicates that their TPACK confidence did not vary by their demographic information and their TPACK practice in teaching mathematics and integration of digital technologies was not determined by teachers' demographic variables (Henry, 1993). However, Bos (2011) conducted a mixed method study to investigate the influence of TPACK lesson planning development on mathematics teachers' TPACK growth and found that mathematics-teaching experience can support the TPACK development.

*H2. There is a statistically significant linear relationship between mathematics teachers' self-perceived knowledge in technology, pedagogy, and mathematics content and their teaching effectiveness.*

Saudi mathematics teachers' TPACK self-efficacy was found to be unrelated to their teaching effectiveness ratings, an unexpected finding (Lyublinskaya & Tournaki, 2012). This result might relate to different beliefs of the potential impact of digital technologies in teaching mathematics between teachers and principals, but no information was obtained about principal' attitudes toward the integration of digital technologies in teaching mathematics. In addition, mathematics teachers might overestimate their technological pedagogical content knowledge (TPACK), and thus their practices of TPACK in their mathematics teaching were less effective than what they were thinking (Hervey, 2011; Kimberly A. Lawless & Pellegrino, 2007; Lyublinskaya & Tournaki, 2012). Furthermore, misunderstanding the TPACK construct can influence their TPACK practice and lead to less effective teaching practices (Bos, 2011; Lux, 2010).

*H3. Saudi Arabian 7-12 mathematics teachers rate their level of preparation at high in integrating digital technologies in teaching mathematics.*

Saudi Arabian mathematics teacher are satisfied with the level of preparation they have received in their teacher education courses; however they expressed their discontent with the professional training programs they have been provided during one school year, which is consistent with the results of other research (Al-Jarf, 2006; Albalawi, 2007; Albalawi & Ghaleb, 2011; Alshumaim & Alhassan, 2010; Dodeen et al., 2012; Mullis et al., 2008; Oyaid, 2010). Their dissatisfaction related either to receiving no or limited professional training or their participation in less effective training. This finding may be caused by the lack of qualified trainers or training programs that focus on training mathematics teachers to teach *about* digital technologies not *with* digital technologies (Niess et al., 2008). Niess and her colleagues (2008) claimed that mathematics teachers need to learn how to teach with digital technologies (TPACK) in order to effectively integrate digital technologies in their teaching practices.

*H4. There is a statistically significant linear relationship between teacher effectiveness and preparation level to integrate digital technologies in teaching mathematics.*

Saudi Arabian mathematics teachers' perceptions of their preparation level to integrate digital technologies in teaching mathematics were slightly negatively related to their principals' ratings for their teaching effectiveness. Furthermore, the grade level of teaching was the only variable that explained the variance of teacher effectiveness rates in attending professional training programs in mathematics and mathematics education, but even this was a small percent. The limited amount of professional training Saudi mathematics teachers received in all content area preparation hindered the significance of teachers' categorical variables in explaining the variance among the principal ratings of their teacher effectiveness.

*H5. There is a statistically significant linear relationship between the perceived knowledge and preparation level of Saudi Arabian 7-12 mathematics teachers with respect to digital technologies integration.*

Saudi Arabian mathematics teachers tend to have high TPACK self-efficacy when they have high satisfaction with their preparation to integrate digital technologies in their teaching. In fact, their perceptions of the influence of their teacher education courses on integrating digital technologies in their teaching can predict their TPACK self-efficacy higher than their perception of the impact of professional development programs. In addition, whether mathematics teachers attend a professional training during their current school year did not explain a lot of the variance in their TPACK self-efficacy. These results can be explained by the high number of teacher education courses in comparison to their professional training hours and the large number of novice teachers among participants who did not attend any professional training programs. There was at least 68% of novice teachers (no teaching experience) who did not receive any professional training programs in any content area (mathematics, mathematics education, educational technology, technology or other) during their current school year.

*H6. There is a statistically significant relationship between mathematics teachers' demographic variables (age, level of education, number of teaching grade level, classroom size, major, school of graduation, teachers' aptitude test scores, years of teaching mathematics, years of teaching other subject matter, and teaching experience) and their teaching effectiveness.*

The demographic variables do not explain the variance in principal rating of teacher effectiveness, although variables such as level of education, major, teachers' aptitude test scores, and teaching experience are common proxies for teacher quality (Darling-Hammond, 2002; Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005; Nye et al., 2004; Strong, 2011; Stronge, 2007; Stronge & Hindman, 2006; H. Wenglinsky, 2002). This finding raises the question of how Saudi middle and high school principals define the effective mathematics teacher. Although school administrator evaluations have limited validation because of the variation of principals' observations abilities (Strong, 2011), they are expected to define the most and least effective teachers because of principals' frequent opportunities to observe teachers on a daily basis and discern their students' achievement gains (Jacob & Lefgren, 2006, 2008). There was no information obtained that identified the quality of school principals, but the qualifications for hiring school administrators showed that they have to have at least four years of experience in teaching and school administration, as provided by the official web site of the Ministry of Education in Saudi Arabia (General Directorate of Educational Supervision, 2007).

*H7. There is a statistically significant relationship between the level of anxiety regarding teaching mathematics and teacher effectiveness.*

*H8. There is a statistically significant relationship between the level of anxiety regarding teaching with technology and teacher effectiveness.*

Mathematics and digital technology anxieties as mathematics teachers perceived were not factors in explaining the relationship between teacher effectiveness and teachers' knowledge of content, pedagogy, and technology. However, this finding may be different according to variation in teachers' use of digital technologies in their classroom, though data to support this claim has not been collected, as the topic, although important, was beyond the scope of the study.

## Implications of Findings

**Theoretical implications.** The findings of this study postulate important assumptions about mathematics teachers' TPACK and its influence on their teaching effectiveness. One assumption regarding mathematics teachers' TPACK self-efficacy is that a high level of TPACK does not necessarily entail a high level of teaching effectiveness. However, high self-perceived TPACK means high level of motivation to integrate digital technologies in teaching mathematics. Second, it is assumed that mathematics teachers' perceptions of their preparation level are related to their perceived TPACK efficacy. Therefore, measuring the impact of such a variable on mathematics teachers' TPACK should be attentively considered when examining the relationship between technological pedagogical mathematics knowledge (TPACK or TPAMK) and teacher effectiveness. However, none of the teacher quality proxies (e.g., teaching experience, educational level, major) was a significant factor in explaining this relationship, which supports the theory of limited to no relationship between these demographic variables and teacher effectiveness (Strong, 2011; Stronge, 2007).

**Research implications.** The self-evaluation measure of TPACK in this study provided valuable information about teachers' TPACK and holds a high degree of validity and reliability to be used with in-service middle and high school mathematics teachers. However, limited inferences can be made about the complex problem of integration digital technologies in teaching mathematics (Mishra & Koehler, 2006), and there is a need for a more comprehensive understanding of teacher knowledge in this complexity that includes all aspects of mathematics teaching in their contexts (Ronau & Rakes, 2012a; Ronau et al., 2010). Therefore, analysis of teachers' TPACK and their teaching effectiveness need to be more comprehensive and wider in order to include individuals (e.g., teachers, students, and principals) and environment (e.g., classroom, school, curriculum, educational technology resources). The variation of information resources can be accommodated by a variation of data collection tools such as 1) classroom observations to measure mathematics TPACK or TPAMK (Lyublinskaya & Tournaki, 2012) and teacher effectiveness (Strong, 2011); 2) standardized tests, like Learning for Mathematics Teaching (LMT) Project (LMT, 2006) or Diagnostic Teacher Assessment for Mathematics and Science (DTAMS) (DTAMS, 2006) to measure teachers' knowledge; 3) student achievement measures like Value-Added Model (VAM) (Strong, 2011); and 4) other alternative teacher effectiveness measures such as analysis of teachers' artifacts and lesson plans; and surveys of teachers' , students', and principals' opinions. In this regard, principals' beliefs, attitudes, and predispositions toward integrating digital technologies in teaching mathematics are easier to control when asking them to rate their teachers' effectiveness to measure the relationship between principals' beliefs about digital technologies and their ratings for their teachers' use of digital technologies. Also, the availability of digital technologies in the classroom and the frequency of use are two other important variables that should be considered when measuring technological pedagogical mathematics knowledge of teacher. Finally, it would be important to identify their current level of TPACK development (recognizing, accepting, adapting, exploring, and advancing) (Niess et al., 2009) and how it is related to their level of mathematics teaching effectiveness.

**Applied implications.** The findings of this study showed that mathematics teachers' TPACK self-efficacy cannot predict their principals' ratings of their teaching effectiveness. Further investigation is needed to examine the cause(s) for such insignificant relationship between principals and mathematics teachers, which can be around the definition of the teacher quality or the role of digital technologies in teaching mathematics. If there is a disagreement between teachers and school administrators about the critical role of digital technology in teaching mathematics, then it might prevent the improvement for the educational system and cause the low level of student achievement in the TIMSS 2007 (Mullis, et al., 2008). Therefore, policymakers, superintendents, educational leaders, and teacher educators should take this dilemma into consideration before implementing any new reform for the educational system. Sharing a positive attitude about the role of digital technologies in teaching and learning mathematics among teachers and administrators will help the effective integration of digital technologies in mathematics education.

In addition, it appeared that there is a dearth of professional development programs to support the integration of digital technologies for mathematics teachers in middle and high public schools in Riyadh, Saudi Arabia. Therefore, more professional training programs that target technological pedagogical mathematics knowledge of teachers and their integration of digital technologies are recommended, and these should align with the TPACK and CFTK frameworks. These professional development programs need to be provided to mathematics teachers in their schools in a gradual and continuous process, and they should be offered all technical supports required to improve their TPACK levels (Boling & Beatty, 2012). Saudi teachers and administrators will benefit from asking for increased awareness of professional development for the acquisition of technological pedagogical and content knowledge. The teachers clearly preferred the knowledge that they gained from the university courses in how to integrate technology more than the professional training; therefore, schools may benefit from getting universities involved in the process of developing highly effective professional training programs.

The research instruments (teacher's and principals' surveys) can be utilized to evaluate the effectiveness of mathematics teacher educational programs and professional training programs focused on improving teacher's TPACK self-efficacy. The TPACK self-efficacy part of the teachers' survey can be used as a metacognitive tool to help both experienced and prospective mathematics teachers reflect upon their understanding of the TPACK (Lux, 2010).

**Limitations of the Study**

This study has a number of limitations, as follows:

1. This study only focused on middle and high school male mathematics teachers in Saudi public schools and may not be representative or generalized to the entire teacher population.
2. The correlational research design that was utilized in this study can only describe the linear relationship between dependent and independent variables. Therefore, no conclusion about cause and effect relationship between mathematics teachers' TPACK

and teacher effectiveness can be provided with the absence of experimental conditions.

3. This study was applied within only one city, Riyadh, in Saudi Arabia.
4. The generalizability of the results is limited because of the nonprobability sampling strategy (also called ad hoc sampling) that was used to recruit participants (Johnson & Christensen, 2010; Salkind, 2012) since it has some percentages of subjectivity.
5. Teachers' technological pedagogical content knowledge (TPACK) was measured once by a self-evaluation questionnaire and its validity could be threatened by participants' self-perceptions. In addition, teacher effectiveness was assessed by a principal's evaluation, and although it is better than traditional measures (e.g., educational level and teaching experience), it is less valid than classroom observation and value-added modeling (VAM) (Strong, 2011).

**Recommendations for Future Research**

There are several recommendations for future research based on the finding of this study. First, future research should control for confounding variables (e.g., curriculum, school environment, students' and parents' attitudes toward digital technologies) with a more robust sampling procedure (e.g., simple random sampling) and increase the statistical power with a large sample size. Second, results could be further developed by evaluating the relationship between teachers' mathematics TPACK and their teaching effectiveness with more comprehensive and reliable evaluation tools like observing teachers practices in their classrooms over a period of time, analyzing teaching artifacts, and measuring student achievement through value-added modeling.

**Final Conclusions**

Saudi Arabian mathematics teachers in male-only middle and high public schools in Riyadh rated their mathematics TPACK at high level. However, their principals' ratings of their teaching effectiveness did not significantly correlate with their TPACK self-efficacy. Principals' beliefs about the quality of teaching might not similar to what teachers have. In fact, this absence of significant relationship between principals and teachers may indicate a misunderstanding among members of a working team that may prevent the improvement of the educational system. Also, it may denote the need to include principals in professional training programs that focus on digital technologies integration so that they will have the same level of knowledge and skills as teachers do and so that principals can enhance how accurately they can evaluate teachers' effective integration of digital technologies. Principals' qualities of effectiveness include, in addition to instructional leadership and teacher evaluation skills, the ability to recognize the role of digital technologies in education and managing their school technological resources (Stronge, Richard, & Catano, 2008). In fact, in recognition of their important role in this endeavor (Creighton, 2003; Ertmer et al., 2002; Office of Technology Assessment, 1995) and to address the problem of principals' weaknesses in integrating technologies effectively (Ertmer et al., 2002; Mehlinger & Powers, 2002), the Collaborative for Technology Standards for School Administrators (TSSA) (2001) and the International Society for Technology in Education (ISTE) developed the National Educational Technology Standards (NETS) for Administrators (2009), which provide guidelines for the effective leadership of digital technology integration. School administrators are receiving less emphasis on technology integration development during their higher education programs and in the field, while teachers receive the majority of the focus (Ertmer et al., 2002; Mehlinger & Powers, 2002). As a result, the integration of digital technologies in mathematics education must take into consideration all school communities of practice (CoP) –these include students, teachers, principals, superintendents, teacher supervisors, curriculum developers, technical support staff, technology developers, professional development trainers, parents, teacher educators, and policymakers– in regard to identifying, planning, and implementing professional development programs.

In fact, the whole school communities of practice should work toward the effective integration of technologies that would support the effective teaching and learning of mathematics, and an important part of this ultimate objective is teachers' acquiring the technological pedagogical content knowledge (TPACK). Teachers, when they have acquired the advanced level of technological pedagogical mathematics knowledge, will understand how the three domains of knowledge (content, pedagogy, and technology) can be synthesized to effectively integrate digital technologies (Mishra & Koehler, 2006; Niess et al., 2009) as well as understand how to actively engage and generate productive interactions among the elements of Comprehensive Framework for Teaching Mathematics (CFTK)– which is composed of individual, environment, orientation, discernment, pedagogy, and subject matter– to improve instruction (Ronau & Rakes, 2012a; Ronau et al., 2010).

Mathematics teachers in Saudi public schools are provided with limited to no professional training support to integrate digital technologies in their teaching, and this could explain why their principals feel that they are less effective teachers. Mathematics teachers as well as their principals need to receive high quality professional training programs that support the TPACK development in order to integrate digital technologies effectively in teaching and learning mathematics. Saudi mathematics teachers in middle and high public schools have high TPACK self-efficacy and that will help them in their TPACK development toward the effective integration of digital technologies in teaching mathematics. Increasing the level of preparation of mathematics teachers through educational technology resources and supports in their schools that align with the TPACK and CFTK framework will help to increase their teaching effectiveness.

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Appendix A

Teacher's Survey – Old Version

Survey # ____

***Part One:*** *This part will measure your self-perceived knowledge of content, pedagogy, and technology. For the purpose of this study, technology term is used to refer to digital tools and resource such as computers, laptops, iPods, handhelds, interactive whiteboards, software programs, etc. Please answer all of the questions and if you are uncertain of or neutral about your response you may always select "Neither Agree or Disagree"*

| | Strongly Disagree | Disagree | Neither Agree or Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 1. I know how to solve my own technical problems. | | | | | |
| 2. I can learn technology easily. | | | | | |
| 3. I keep up with important new technologies. | | | | | |
| 4. I frequently play around with the technology. | | | | | |
| 5. I know about a lot of different technologies. | | | | | |
| 6. I have the technical skills I need to use technology. | | | | | |
| 7. I have had sufficient opportunities to work different technologies. | | | | | |
| 8. I have sufficient knowledge about mathematics. | | | | | |
| 9. I can use a mathematical way of thinking. | | | | | |
| 10. I have various ways and strategies of developing my understanding of mathematics. | | | | | |
| 11. I know how to assess student performance in a classroom. | | | | | |
| 12. I can adapt my teaching based-upon what students currently understand or do not understand. | | | | | |
| 13. I can adapt my teaching style to different learners. | | | | | |
| 14. I can assess student learning in multiple ways. | | | | | |
| 15. I can use a wide range of teaching approaches in a classroom setting. | | | | | |
| 16. I am familiar with common student understandings and misconceptions. | | | | | |
| 17. I know how to organize and maintain classroom management. | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 18. I can select effective teaching approaches to guide student thinking and learning in mathematics. | | | | | |
| 19. I can select effective teaching approaches to illustrate difficult mathematical concepts. | | | | | |
| 20. I can select effective teaching approaches that reflect my student’s prior knowledge. | | | | | |
| 21. I know about technologies that I can use for understanding and doing mathematics. | | | | | |
| 22. I know about technologies that can deepen my content area knowledge. | | | | | |
| 23. I know about technologies that I can use to represent mathematical concepts. | | | | | |
| 24. I can choose technologies that enhance the teaching approaches for a lesson. | | | | | |
| 25. I can choose technologies that enhance students' learning for a lesson. | | | | | |
| 26. My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom. | | | | | |
| 27. I am thinking critically about how to use technology in my classroom. | | | | | |
| 28. I can adapt the use of the technologies that I am learning about to different teaching activities. | | | | | |
| 29. I can teach lessons that appropriately combine mathematics, technologies and teaching approaches. | | | | | |
| 30. I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district. | | | | | |
| 31. I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom. | | | | | |
| 32. I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn. | | | | | |

***Part Two:*** *This part will measure your perceived perceptions of your teacher education program and professional training. Please answer all of the questions and if you are uncertain of or neutral about your response you may always select "Neither Agree or Disagree"*

**Terminologies:**
Mathematics = Mathematics content
Mathematics Educational Methods = teaching methods for mathematics
Technology = how to use technology
Technology education = how to teach with technology

**1. How many courses you have taken in each of the following areas?**

Mathematics ____ Mathematics Educational Methods ____
Educational Technology ___ Technology (e.g., computing, programming, etc.) ____

**2. The courses I have completed have prepared me to integrate digital technology in my teaching effectively:**

| | Strongly Disagree | Disagree | Neither Agree or Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Mathematics | | | | | |
| Mathematics Educational Methods | | | | | |
| Technology Education | | | | | |
| Technology | | | | | |

**3. Using a letter grade scale of A, A-, B+, B, B-, C+, C, C-, D+, D, D-, F**

Estimate your average grade in Mathematics courses: ____

Estimate your average grade in Technology courses: ____

Estimate your average grade in Mathematics Educational Methods courses: ____

Estimate your average grade in Educational Technology courses: ____

**4. How many hours of professional training or workshops you have attend this year in each of the following areas?**

Mathematics ____ Mathematics Education ____
Educational Technology ___ Technology (e.g., computing, programming, etc.) ____
Other ___ (please, specify) ____________

**5. The professional training or workshops I have completed have prepared me to integrate digital technology in my teaching effectively:**

| | Strongly Disagree | Disagree | Neither Agree or Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Mathematics | | | | | |
| Mathematics Educational Methods | | | | | |
| Educational Technology | | | | | |
| Technology | | | | | |

***Part Three:*** *This part will measure your anxiety level about teaching mathematics and using technology in your teaching. Please answer all of the questions and if you are uncertain of or neutral about your response you may always select "Neither Agree or Disagree"*

| | Strongly Disagree | Disagree | Neither Agree or Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1. I have anxiety about teaching mathematics? | | | | | |
| 2. I have anxiety about teaching with technology? | | | | | |

***Part Four****: The purpose of this part of the survey is to elicit some demographic information about you. For the following 11 items, please choose or input the item that best describes your demographics*

**DEMOGRAPHIC INFORMATION**

1. What grade are you teaching this year? _________

2. What is your year of teaching experience? (If you are a first-year teacher, please put 0) _____

3. How many years have you taught math? ___

4. How many years have you taught subject matter other than mathematics? _____

5. What is your level of education?

    a. Lower than Bachelor
    b. Bachelor
    c. Master

d. Doctorate

6. What is your major?

a. Mathematics
b. Mathematics Education
c. Elementary Education
d. Secondary Education
e. Other (please specify) ____________

7. What is your school type?

a. General
b. Quranic

8. To any directorate your school belongs?

a. The General Directorate for Education
b. The Department of Culture and Education of the Armed Forces

9. Age: _____

10. Nationality

a. Saudi
b. Other ______________

11. Your e-mail address (If you do not have one, please put NA)

Thank you,

Appendix B

Teachers' Effectiveness Questionnaire – Old Version

Teacher's Survey # _______

**Instruction:** after entering your teacher's survey number, please rate your mathematics teacher's effectiveness in each of the fourteen professional areas.

**Question:** In comparison to other mathematics teachers who you have worked with, rate this teachers effectiveness in each area:

| N | Areas | Upper 10% | Upper 25% | Upper 50% | Lower 50% | Lower 20% |
|---|---|---|---|---|---|---|
| 1 | Teaching Methods | | | | | |
| 2 | Knowledge of the content they teach | | | | | |
| 3 | Effective use of technology | | | | | |
| 4 | Initiative | | | | | |
| 5 | Creativity | | | | | |
| 6 | Enthusiasm | | | | | |
| 7 | Ability to work with supervisors | | | | | |
| 8 | Ability to work with peers | | | | | |
| 9 | Rapport with parents | | | | | |
| 10 | Rapport with pupils | | | | | |
| 11 | Classroom planning | | | | | |
| 12 | Ability to maintain discipline | | | | | |
| 13 | Willingness to improve professionally | | | | | |
| 14 | Overall teaching success | | | | | |

# Appendix C

## Informed Consent Statement

The Department of Curriculum and Teaching at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You should be aware that even if you agree to participate, you are free to withdraw at any time without penalty.

We are conducting this study to better understand the current mathematics teachers' technological pedagogical content knowledge level and its relationship to teacher effectiveness. This will entail your completion of a questionnaire. The questionnaire packet is expected to take approximately 30 minutes to complete.

The content of the questionnaires should cause no more discomfort than you would experience in your everyday life. Although participation may not benefit you directly, we believe that the information obtained from this study will help us gain a better understanding of the current mathematics teachers' technological pedagogical content knowledge level and its relationship to teacher effectiveness. Your participation is solicited, although strictly voluntary. Your name will not be associated in any way with the research findings. If you would like additional information concerning this study before or after it is completed, please feel free to contact us by phone or mail.

Completion of the survey indicates your willingness to participate in this project and that you are at least age eighteen. If you have any additional questions about your rights as a research participant, you may call (785) 864-7429, write the Human Subjects Committee Lawrence Campus (HSCL), University of Kansas, 2385 Irving Hill Road, Lawrence, Kansas, 66045-7563, or email irb@ku.edu.

Sincerely,

Khaled A. Alshehri
Principal Investigator
Department of Curriculum and Teaching
University of Kansas
Joseph R. Pearson Hall
Lawrence, KS, 66045
(785) 727-9155
khaled@ku.edu

Ronald Aust, Ph.D.
Faculty Supervisor
Department of Educational Leadership and Policy Studies
Joseph R. Pearson Hall, Rm 408
University of Kansas
Lawrence, KS, 66045
(785) 864-3466
aust@ku.edu

Appendix D

Teacher's Letter

Dear Mathematics Teacher,

This survey questionnaire is part of a doctoral study conducted to investigate how the self-perceived expertise of 7-12 grade Saudi Arabian mathematics teachers in 1) mathematics content, 2) teaching pedagogy, and 3) technology integration relates to their teaching effectiveness. For the purpose of this study, technology is used to refer to digital tools and resource such as computers, the Internet, blogs, interactive whiteboards, educational software, calculators, PDA and other handheld devices.

Please take some time to participate in this study. Your input will be kept confidential and will only be used for the purpose of conducting this study. The questionnaire consists of four parts and will take about 30 minutes to complete.

The time you put in completing this survey is highly appreciated. If you have questions, suggestions or comments, please do not hesitate to contact us.

Sincerely,

Khaled A. Alshehri
Principal Investigator
Department of Curriculum and Teaching
University of Kansas
4712 Moundridge ct.
Lawrence, KS, 66049
(785) 727-9155
khaled@ku.edu

Ron Aust, Ph.D.
Faculty Supervisor
Department of Educational Leadership and Policy Studies
Joseph R. Pearson Hall, Rm 408
University of Kansas
Lawrence, KS, 66045
(785) 864-3466
aust@ku.edu

Appendix E
Teacher's Survey

Survey # ____

***Part One:** This part will measure your self-perceived knowledge of content, pedagogy, and technology. For the purpose of this study, technology term is used to refer to digital tools and resource such as computers, laptops, iPods, handhelds, interactive whiteboards, software programs, etc. Please answer all of the questions and if you are uncertain of or neutral about your response you may always select "Neither Agree or Disagree"*

| | Strongly Disagree | Disagree | Neither Agree or Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 1. I know how to use different digital technologies. | | | | | |
| 2. I know how to solve my own technical problems with digital technologies. | | | | | |
| 3. I frequently play around with digital technologies. | | | | | |
| 4. I keep up with important new digital technologies. | | | | | |
| 5. I reason mathematically when I solve problems in my daily life. | | | | | |
| 6. I can make mathematical connections with the problems outside of mathematics. | | | | | |
| 7. I am able to communicate mathematically. | | | | | |
| 8. I use multiple mathematical representations when I solve problems. | | | | | |
| 9. I know how to adapt lessons to improve student learning. | | | | | |
| 10. I know how to implement a wide range of instructional approaches. | | | | | |
| 11. I know how to organize a classroom environment for learning. | | | | | |
| 12. I know how to assess student performance in a classroom. | | | | | |
| 13. I have a good understanding of teaching mathematics so that students are able to learn. | | | | | |
| 14. I have a good understanding of instructional strategies that best represent mathematical topics. | | | | | |
| 15. I have a good understanding of students' conceptual and practical understanding of mathematical concepts. | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 16. I have a good understanding of the mathematics curriculum that meets students' needs for learning mathematics. | | | | | |
| 17. I know how to use digital technologies to represent mathematical ideas. | | | | | |
| 18. I am able to select certain digital technologies to communicate mathematical processes. | | | | | |
| 19. I am able to use digital technologies to solve mathematics problems. | | | | | |
| 20. I am able to use digital technologies to explore mathematical ideas. | | | | | |
| 21. I am able to identify digital technologies to enhance the teaching approaches for a lesson. | | | | | |
| 22. I can implement specific digital technologies to support students' learning for a lesson. | | | | | |
| 23. I think deeply about how digital technologies influence teaching approaches I use in my classroom. | | | | | |
| 24. I can adapt digital technologies to support learning in my classroom. | | | | | |
| 25. I know specific topics in mathematics are better learned when taught through an integration of digital technologies with my instructional approaches. | | | | | |
| 26. I can identify specific topics in the mathematics curriculum where specific digital technologies are helpful in guiding student learning in the classroom. | | | | | |
| 27. I can use strategies that combine mathematical content, digital technologies and teaching approaches to support students' understandings and thinking as they are learning mathematics. | | | | | |
| 28. I can select digital technologies to use with specific instructional strategies as I guide students in learning mathematics. | | | | | |

***Part Two:*** *This part will measure your perceived perceptions of your teacher education program and professional training. Please answer all of the questions and if you are uncertain of or neutral about your response you may always select "Neither Agree or Disagree"*

**Terminologies:**
Mathematics = Mathematics content
Mathematics Educational Methods = teaching methods for mathematics
Technology = how to use technology
Technology education = how to teach with technology

**1. How many courses you have taken in each of the following areas?**

Mathematics ____ Mathematics Educational Methods ____
Educational Technology ___ Technology (e.g., computing, programming, etc.) ____

**2. The courses I have completed have prepared me to integrate digital technologies in my teaching effectively:**

| | Strongly Disagree | Disagree | Neither Agree or Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Mathematics | | | | | |
| Mathematics Educational Methods | | | | | |
| Educational Technology | | | | | |
| Technology | | | | | |

**3. Using a letter grade scale of A+, A, A-, B+, B, B-, C+, C, C-, D+, D, D-, F**

Estimate your average grade in Mathematics courses: ____

Estimate your average grade in Technology courses: ____

Estimate your average grade in Mathematics Educational Methods courses: ____

Estimate your average grade in Educational Technology courses: ____

**4. How many hours of professional training or workshops you have attended this year in each of the following areas?**

Mathematics ____ Mathematics Education ____
Educational Technology ___ Technology (e.g., computing, programming, etc.) ____
Other ___ (please, specify) ____________

**5. The professional training or workshops I have completed have prepared me to integrate digital technologies in my teaching effectively:**

| | Strongly Disagree | Disagree | Neither Agree or Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Mathematics | | | | | |
| Mathematics Educational Methods | | | | | |
| Educational Technology | | | | | |
| Technology | | | | | |

***Part Three:*** *This part will measure your anxiety level about teaching mathematics and using technology in your teaching. Please answer all of the questions and if you are uncertain of or neutral about your response you may always select "Neither Agree or Disagree"*

| | Strongly Disagree | Disagree | Neither Agree or Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1. I have anxiety about teaching mathematics. | | | | | |
| 2. I have anxiety about teaching with technology. | | | | | |

***Part Four****: The purpose of this part of the survey is to elicit some demographic information about you. For the following 11 items, please choose or input the item that best describes your demographics*

**DEMOGRAPHIC INFORMATION**

1. What grades are you teaching this year? ________
2. How many students, on average, do you have in a classroom? _________
3. What is your year of teaching experience? (If you are a first-year teacher, please put 0) ____
4. How many years have you taught math? ___
5. How many years have you taught subject matter other than mathematics? ____

6. What is your level of education?
   a. Lower than Bachelor
   b. Bachelor
   c. Master
   d. Doctorate

7. What was your major?
   a. Mathematics
   b. Mathematics Education
   c. Elementary Education
   d. Secondary Education
   e. Other (please specify) ____________

8. What school did you graduate from?
   a. Riyadh Teachers College
   b. King Saud University
   c. Imam Muhammad Ibn Saud University
   d. Other (please specify) _____________

9. What was your score in Teachers Aptitude Test that the national center for assessment in Higher Education (NCAHE or as called QIYAS) provides?

   a. In the educational part: _____
   b. In the language part: _____
   c. In the numerical part: _____
   d. In the major part: _____
   e. The overall score: _____

10. Age: _____

11. Your e-mail address (If you do not have one, please put NA)

Thank you,

Appendix F

Principal's Letter

Dear Administrator,

We are requesting your assistance in a research study to investigate how the self-perceived expertise of 7-12 grade Saudi Arabian mathematics teachers in 1) mathematics content, 2) teaching pedagogy, and 3) technology integration relates to their teaching effectiveness. Mathematics teachers will rate their knowledge in mathematics, pedagogy and digital technologies, in addition to evaluate their teacher education and professional development programs. We are asking you to rate your teachers' effectiveness.

There are fourteen areas to be rated and we assure absolute anonymity. Only you will know the name of the teachers; no one except for you will have a way of connecting the name of the teacher with their effectiveness rating, and this information will not be shared with teachers.

In this envelope, you should find one listing form, teaching effectiveness surveys, and teacher's surveys. First, you will place each teacher's survey number next to his name in the listing form, which you will keep. Then you will complete a teachers' effectiveness survey for each mathematics teacher in your school after placing teacher's survey number on each one. Finally, you will send us the completed teacher's surveys and teachers' effectiveness surveys.

The time you put in completing this survey is highly appreciated. If you have questions, suggestions or comments, please do not hesitate to contact us.

Sincerely,

Khaled A. Alshehri
Principal Investigator
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4712 Moundridge ct.
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Lawrence, KS, 66045
(785) 864-3466
aust@ku.edu

Appendix G

Listing Form

| N | Teacher's Name | Teacher's Survey Number |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

Note: This form is for you to keep tracking of teachers' survey numbers, so please destroy it when you finish completing your teachers' effectiveness surveys.

Appendix H

Teachers' Effectiveness Questionnaire

Teacher's Survey # _______

**Instruction:** after entering your teacher's survey number, please rate your mathematics teacher's effectiveness in each of the fourteen professional areas.

**Question:** In comparison to other mathematics teachers who you have worked with, rate this teacher's effectiveness in each area:

| N | Areas | Lower 20% | Lower 50% | Upper 50% | Upper 25% | Upper 10% |
|---|---|---|---|---|---|---|
| 1 | Teaching Methods | | | | | |
| 2 | Knowledge of the content he teaches | | | | | |
| 3 | Effective use of technology | | | | | |
| 4 | Initiative | | | | | |
| 5 | Creativity | | | | | |
| 6 | Enthusiasm | | | | | |
| 7 | Ability to work with supervisors | | | | | |
| 8 | Ability to work with peers | | | | | |
| 9 | Rapport with parents | | | | | |
| 10 | Rapport with pupils | | | | | |
| 11 | Classroom planning | | | | | |
| 12 | Ability to maintain discipline | | | | | |
| 13 | Willingness to improve professionally | | | | | |
| 14 | Overall teaching success | | | | | |

# Appendix I

## Panel of Reviewing Experts

**Ronald Aust** is an Associate Professor of Educational Technology at the University of Kansas. His research interests are in Educational Technology Integration, eGlossaries, Instructional Design, eCollaborative Learning, e-Learning in international settings, and Educational Content Organizing and Managing. Dr. Aust is one of the pioneers in the development of the UNITE distributed learning system which established the Explorer collection in 1993 as one of the first educational libraries on the Internet. He has directed or co-directed a research projects on educational technology with over $16 million of funded. Recently he directed the development of WWW sites; eLearing Design Lab, Four Directions Challenge, The Explorer/UNITE system) that is serving over 15,000 pages daily. He has many publications in educational technology and instructional design.

**Neal Kingston** is a Professor of Psychology and Research in Education at the University of Kansas. He is also the director of the Center for Educational Testing and Evaluation and Coordinator for the Research, Evaluation, Measurement, and Statistics Program at the University of Kansas. His research interests and publications are in large-scale assessment, item response theory, computer-based testing, and research design. Dr. Kingston also serves as a consultant to several testing organizations. He served as GM and Vice President, Research at CTB McGraw Hill and SVP, COO at Measured Progress, and Associate Commissioner at Kentucky Department of Education.

**Irina Lyublinskaya** is a Professor of Mathematics and Science Education at the College of Staten Island, City University of New York. Her research interests are in integration technology into mathematics and science education, prospective and experienced mathematics and science teachers' professional development. Dr. Lyublinskaya has published 14 books, 3 chapters and journal articles about teaching of mathematics, science and educational technology. She has received RadioShack/Tandy Prize for Teaching Excellence Mathematics, Science and Computer Science, NSTA Distinguished Science Teaching Award and citation, Education's Unsung Heroes Award for innovation in the classroom and NSTA Vernier Technology Award.

**Margaret (Maggie) L. Niess** is a Professor Emeritus of Mathematics Education in the Department of Science and Mathematics Education at Oregon State University. Her research interests are in educational technology integration with a special focus on preparing mathematics and science teachers to teach with technology. Recently, she has been deeply focused on teachers development model of technological pedagogical content knowledge (TPACK). Her five level developmental model of TPACK enriched the theoretical base for the TPACK framework. She has published a number of books, chapters and journal articles on the TPACK framework and its five developmental model. Dr. Niess served in many educational positions such as a chair for the Technology Committee for the Association of Mathematics Teacher Educators (AMTE), a member on the Board of Directors for School Science and Mathematics (SSMA), a Vice President of the Teacher Education Council for Society for Information Technology and Teacher Education (SITE), and an editor of School Science and Mathematics Journal.

# Appendix J
# Human Subjects Committee Approval

KU RESEARCH & GRADUATE STUDIES
The University of Kansas

7/13/11
HSCL #19515

Khaled Alshehri
4712 Moundridge Ct.
Lawrence, KS 66049-3738

The Human Subjects Committee Lawrence Campus (HSCL) has reviewed your research project application

19515 Alshehri/Aust (C & T) Mathematics Teachers' Level of Knowledge in Content, Pedogogy, and Technology and Its Influence on Their Teaching Effectiveness in Saudi Public Schools

and approved this project under the expedited procedure provided in 45 CFR 46.110 (f) (7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. As described, the project complies with all the requirements and policies established by the University for protection of human subjects in research. Unless renewed, approval lapses one year after approval date.

Since your research presents no risk to participants and involves no procedures for which written consent is normally required outside of the research context HSCL may waive the requirement for a signed consent form (45 CFR 46.117 (c) (2). Your information statement meets HSCL requirements. TheOffice for Human Research Protections requires that your information statement must include the note of HSCL approval and expiration date, which hassent back to you with this approval.

1. At designated intervals until the project is completed, a Project Status Report must be returned to the HSCL office.
2. Any significant change in the experimental procedure as described should be reviewed by this Committee prior to altering the project.
3. Notify HSCL about any new investigators not named in original application. Note that new investigators must take the online tutorial at http://www.research.ku.edu/tutor/hsp/index.shtml.
4. Any injury to a subject because of the research procedure must be reported to the Committee immediately.
5. When signed consent documents are required, the primary investigator must retain the signed consent documents for at least three years past completion of the research activity. If you use a signed consent form, provide a copyof the consent form to subjects at the time of consent.
6. If this is a funded project, keep a copy of this approval letter with your proposal/grant file.

Please inform HSCL when this project is terminated. You must also provide HSCL with an annual status report to maintain HSCL approval. Unless renewed, approval lapses one year after approval date. If your project receives funding which requests an annual update approval, you must request this from HSCL one month prior to the annual update. Thanks for your cooperation. If you have any questions, please contact me.

Sincerely,

Jan Butin

Jan Butin
Associate Coordinator
Human Subjects Committee - Lawrence

cc: Ronald Aust

KU RESEARCH & GRADUATE STUDIES
The University of Kansas

12/28/2011
HSCL #19515

Khaled Alshehri
4712 Moundridge Ct.
Lawrence, KS 66049-3738

The Human Subjects Committee Lawrence Campus reviewed your research update application for project

19515 Alshehri/Aust (C & T) Mathematics Teachers' Level of Knowledge in Content, Pedagogy, and Technology and Its Influence on Their Teaching Effectiveness in Saudi Public Schools

and approved this project update through an expedited review process according to 45 CFR 46.110 (b)(2) with minor changes in a previously approved project, including:

- Revision to some survey items for validity purposes

Your project has continued approval to 7/13/2012. Approximately one month prior to 7/13/2012, HSCL will send to you a Status Report request, which will be necessary for you to complete in order to obtain continued approval for the next twelve months. Please note that you must stop data gathering if you do not receive continued HSCL approval.

Please use the HSCL "approval stamp" on your consent forms. Just cut and paste. You may resize and reshape the text to fit your documents.

**Approved by the Human Subjects Committee University of Kansas, Lawrence Campus (HSCL) on 12/28/2011. Approval expires one year from 7/13/2011. HSCL# 19515**

If you complete your project before the renewal date, please notify HSCL. Thank you for providing HSCL with update information.

Sincerely,

Jan Butin
HSCL Associate Coordinator

cc: Ronald Aust

Appendix K

Directory of Education in Riyadh Approval

بسم الله الرحمن الرحيم

المملكة العربية السعودية
وزارة التربية والتعليم
الإدارة العامة للتربية والتعليم بمنطقة الرياض
إدارة التخطيط والتطوير

وزارة التربية والتعليم
Ministry of Education

الرقم : ٣٢١٠٥٥١١٩٦
التاريخ : ٩/١٠/١٤٣٢هـ
المشفوعات : ........................

تسهيل مهمة باحث

| الاسم | | بطاقة السجل المدني | |
|---|---|---|---|
| خالد بن عبدالله بن سعيد الشهري | | [redacted] | |
| العام الدراسي | الدرجة العلمية | الكلية | الجامعة |
| ١٤٣٢ | دكتوراه | العلوم الاجتماعية | كانساس |
| عنوان الدراسة : المستوى المعرفي في كل المحتوى وطرق التدريس والتقنية لمعلمي الرياضيات في كل المرحلتين المتوسطة والثانوية وعلاقته بفاعليتهم التدريسية | | | |
| عينة الدراسة : المعلمين في مدارس التعليم العام الحكومية في مدينة الرياض | | | |

**المكرم مدير** ............................ **وفقه الله**

السلام عليكم ورحمة الله وبركاته ، وبعد :

بناء على تعميم معالي الوزير رقم ٥٥/٦١٠ وتاريخ ١٤١٦/٩/١٧هـ بشأن تفويض الإدارات العامة للتربية والتعليم بإصدار خطابات السماح للباحثين بإجراء البحوث والدراسات . وحيث تقدم إلينا الباحث (الموضحة بياناته أعلاه) بطلب إجراء دراسته ، ونظراً لاكتمال الأوراق المطلوبة نأمل تسهيل مهمته .

مع ملاحظة أن الباحث يتحمل كامل المسؤولية المتعلقة بمختلف جوانب البحث ، ولا يعني سماح الإدارة العامة للتربية والتعليم موافقتها بالضرورة على مشكلة البحث أو على الطرق والأساليب المستخدمة في دراستها ومعالجتها .

شاكرين طيب تعاونكم ،

والسلام عليكم ورحمة الله وبركاته

**مدير إدارة التخطيط والتطوير المكلف**

**سعود بن راشد آل عبد اللطيف**

٤٠١

Appendix L

Equivalency Test Form

Please evaluate the similarity of meaning between the two attached versions of the research instruments. Use yes (Y) when there is an equivalent of meaning or No (N) if not.

1. Teachers' Letter

| | Version A | Version C |
|---|---|---|
| The overall meaning | | |

Comments:

------------------------------------------------------------------------------------------------------------

------------------------------------------------------------------------------------------------------------

------------------------------------------------------------------------------------------------------------

2. Teachers' Survey

| | Version A | Version C |
|---|---|---|
| Part one 's instruction | | |
| Table labels | | |
| Item # 1 | | |
| Item # 2 | | |
| Item # 3 | | |
| Item # 4 | | |
| Item # 5 | | |
| Item # 6 | | |
| Item # 7 | | |
| Item # 8 | | |
| Item # 9 | | |
| Item # 10 | | |
| Item # 11 | | |
| Item # 12 | | |
| Item # 13 | | |
| Item # 14 | | |
| Item # 15 | | |
| Item # 16 | | |
| Item # 17 | | |
| Item # 18 | | |
| Item # 19 | | |
| Item # 20 | | |
| Item # 21 | | |
| Item # 22 | | |
| Item # 23 | | |
| Item # 24 | | |

| | | |
|---|---|---|
| Item # 25 | | |
| Item # 26 | | |
| Item # 27 | | |
| Item # 28 | | |
| Item # 29 | | |
| Item # 30 | | |
| Item # 31 | | |
| Item # 32 | | |
| Part two 's instruction | | |
| Terminologies | | |
| Question # 1 | | |
| Question # 2 | | |
| Question # 3 | | |
| Question # 4 | | |
| Question # 5 | | |
| Part three 's instruction | | |
| Item # 1 | | |
| Item # 2 | | |
| Part four 's instruction | | |
| Item # 1 | | |
| Item # 2 | | |
| Item # 3 | | |
| Item # 4 | | |
| Item # 5 | | |
| Item # 6 | | |
| Item # 7 | | |
| Item # 8 | | |
| Item # 9 | | |
| Item # 10 | | |
| Item # 11 | | |

Comments:

---------------------------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------------------------

3. Principal's Letter

| | Version A | Version C |
|---|---|---|
| The overall meaning | | |

Comments:

---------------------------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------------------------

4. Listing Form

| | Version A | Version C |
|---|---|---|
| Table labels | | |
| Note | | |

Comments:

------------------------------------------------------------------------------------------------------------
------------------------------------------------------------------------------------------------------------
------------------------------------------------------------------------------------------------------------

5. Teachers' Effectiveness Survey

| | Version A | Version C |
|---|---|---|
| Instruction | | |
| Question | | |
| Table labels | | |
| Item # 1 | | |
| Item # 2 | | |
| Item # 3 | | |
| Item # 4 | | |
| Item # 5 | | |
| Item # 6 | | |
| Item # 7 | | |
| Item # 8 | | |
| Item # 9 | | |
| Item # 10 | | |
| Item # 11 | | |
| Item # 12 | | |
| Item # 13 | | |
| Item # 14 | | |

Comments:

------------------------------------------------------------------------------------------------------------
------------------------------------------------------------------------------------------------------------
------------------------------------------------------------------------------------------------------------

Appendix M

Panel of Translation Experts

| | Name | Position | Specializations |
|---|---|---|---|
| 1 | Mujdey Abudalbuh | Lecturer AAAS<br>Certified Translator<br>The University of Kansas | Sociolinguistics, Phonetics |
| 2 | Khalid Alamrah | Lecturer AAAS<br>The University of Kansas | Curriculum & Instruction,<br>TESOL |
| 3 | Jason Barrett-Fox | English Faculty<br>Hesston College | Rhetoric and Composition,<br>Writing Pedagogy |
| 4 | Rebecca Barrett-Fox | Sociology Faculty<br>Hesston College | English, American Studies |
| 5 | Turki Binturki | Ph.D. Student<br>The University of Kansas | Language Acquisition |

Appendix N

Arabic Version of Surveys

استبانة المعلم

عزيزي معلم الرياضيات

السلام عليكم و رحمة الله و بركاته ، هذه الاستبانة جزء من دراسة دكتوراه تهدف لبحث كيفية العلاقة بين فاعلية التدريس و المستوى المعرفي في كل من ١) محتوى المادة و ٢) طرق التدريس و ٣) استخدام تقنيات التعليم لمعلمي الرياضيات في المرحلتين المتوسطة و الثانوية. مفردة التقنية في هذه الدراسة تعنى كل الأدوات و الوسائل الرقمية مثل الحاسب الآلي، الإنترنت، المدونات، السبورة الذكية (السبورة التفاعلية)، البرمجيات التعليمية، الآلات الحاسبة، PDA و غيرها من الاجهزة (الذكية) المحمولة.

نأمل منكم التكرم بالمشاركة في الدراسة من خلال الإجابة على الاستبانة المرفقة. كما نود التأكيد على أن جميع المعلومات التى ستدلي بها في هذه الدراسة سوف يتم استخدامها من قبل الباحث لغرض الدراسة فقط مع الحفاظ على خصوصيتها و سريتها.

الاستبانة تحتوي على أربعة أجزاء و من المتوقع أن لا يستغرق إكمالها أكثر من ٣٠ دقيقة.

إن ما ستبذلونه من وقت ثمين لإكمال هذه الاستبانة هو محل شكرنا و تقديرنا الجزيل، و إذا كان لديكم أي سؤال أو اقتراح أو تعليق فنأمل التواصل معنا.

خالد بن عبدالله الشهري
الباحث الرئيسي
قسم المناهج و طرق التدريس ، جامعة كانساس
عنوان: Joseph R. Pearson Hall
Lawrence, KS, 66045
هاتف: 7857279155
إيميل: khaled@ku.edu

Ronald Aust
المشرف على البحث
قسم القيادة و دراسات السياسة التربوية، جامعة كانساس
عنوان: Joseph R. Pearson Hall, Rm 408
Lawrence, KS, 66045
هاتف: 7858643466
إيميل: aust@ku.edu

**Approved by the Human Subjects Committee University of Kansas, Lawrence Campus (HSCL) on 12/28/2011. Approval expires one year from 7/13/2011. HSCL# 19515**



**استبانة رقم :**

**الجزء الأول:** هذا الجزء سوف يقيس إدراكك الذاتي لمستوى معرفتك بكل من محتوى المادة ، و طرق التدريس، و التقنية. مفردة التقنية في هذه الدراسة تعني كل الأدوات و الوسائل الرقمية مثل الحاسب الآلي بنوعيه المكتبي و المحمول ، أي بود، الأجهزة الكفية، السبورة التفاعلية (الذكية)، البرامج ..... الخ .الرجاء الإجابة على جميع الأسئلة مع التنبيه أنه إذا كنت غير متأكد من الإجابة أو لديك إجابة محايدة فأنه يمكنك دائماً اختيار إجابة (لا أوافق أو أخالف).

| م | | لا أوافق بشدة (١) | لا أوافق (٢) | لا أوافق أو أخالف (٣) | أوافق (٤) | أوافق بشدة (٥) |
|---|---|---|---|---|---|---|
| ١ | أنا أعرف كيف أستخدم أنواع مختلفة من التقنيات الرقمية. | | | | | |
| ٢ | أنا أعرف كيف أحل المشاكل الفنية التي تواجهوني عند أستخدام التقنيات الرقمية. | | | | | |
| ٣ | أنا اتسلى باستخدام التقنيات الرقمية بشكل مستمر. | | | | | |
| ٤ | أنا على اطلاع دائم بالتقنيات الرقمية الحديثة و المهمة. | | | | | |
| ٥ | أنا اوظف التعليل الرياضي عند حل المسائل الرياضية في حياتي اليومية. | | | | | |
| ٦ | أنا أستطيع ربط المسائل غير الرياضية بمادة الرياضيات. | | | | | |
| ٧ | أنا أمتلك القدرة على التواصل الرياضي. | | | | | |
| ٨ | أنا أستخدم العديد من التمثيلات الرياضية عند حل المسائل. | | | | | |
| ٩ | أنا أعرف كيف أتبنى دروس تحسن تعلم الطالب. | | | | | |
| ١٠ | أنا أعرف كيف أطبق نطاق واسع من الاساليب التدريسية. | | | | | |
| ١١ | أنا أعرف كيف أنظم بيئة الصف لتساعد على التعلم. | | | | | |
| ١٢ | أنا أعرف كيف أقيم أداء الطالب في الصف. | | | | | |
| ١٣ | أنا أمتلك فهم جيد لتدريس الرياضيات بحيث يمكن الطلاب من التعلم. | | | | | |
| ١٤ | أنا أمتلك فهم جيد للإستراتيجيات التعليمية التي تمثل المواضيع الرياضية بأفضل صورة. | | | | | |
| ١٥ | أنا أمتلك فهم جيد لفهم الطلاب النظري و العملي للمفاهيم الرياضية. | | | | | |
| ١٦ | أنا أمتلك فهم جيد لمناهج الرياضيات التي تلبي احتياجات الطلاب لتعلم الرياضيات. | | | | | |
| ١٧ | أنا أعرف كيف أستخدم التقنيات الرقمية لتمثيل الافكار الرياضية. | | | | | |
| ١٨ | أنا أستطيع اختيارتقنيات رقمية معينة لتوصيل مفهوم العمليات الرياضية. | | | | | |
| ١٩ | أنا أستطيع أستخدام التقنيات الرقمية لحل المسائل الرياضية. | | | | | |
| ٢٠ | أنا أستطيع أستخدام التقنيات الرقمية لإستكشاف الأفكار الرياضية. | | | | | |

| م | | لا أوافق بشدة (١) | لا أوافق (٢) | لا أوافق أو أخالف (٣) | أوافق (٤) | أوافق بشدة (٥) |
|---|---|---|---|---|---|---|
| ٢١ | أنا أستطيع التعرف على التقنيات الرقمية التي تعزز أساليب التدريس للدرس. | | | | | |
| ٢٢ | أنا أستطيع تطبيق تقنيات رقمية معينة لدعم تعلم الطلاب للدرس . | | | | | |
| ٢٣ | أنا أفكر بعمق في كيفية تأثير التقنيات الرقمية على طرق التدريس التي استخدمها في صفي الدراسي. | | | | | |
| ٢٤ | أنا أستطيع تبني تقنيات رقمية تدعم التعلم في صفي الدراسي. | | | | | |
| ٢٥ | أنا أعرف مواضيع محددة في الرياضيات تتعلم بشكل أفضل عندما تدرس من خلال دمج التقنيات الرقمية في طرق تدريسي. | | | | | |
| ٢٦ | أنا أستطيع التعرف على مواضيع معينة في منهج الرياضيات يمكن لتقنيات رقمية محددة أن تساعد في توجيه تعلم الطالب لها في الصف الدراسي. | | | | | |
| ٢٧ | أنا أستطيع أستخدام أستراتيجيات تجمع بين المحتوى الرياضي، و التقنيات الرقمية، و طرق التدريس لدعم فهم و تفكير الطلاب عند تعلمهم للرياضيات. | | | | | |
| ٢٨ | أنا أستطيع اختيار تقنيات رقمية لإستخدامها مع أستراتيجيات تعليمية لتوجيه تعلم الطلاب للرياضيات. | | | | | |

**الجزء الثاني**: هذا الجزء سوف يقيس تصوراتك عن برنامجي إعداد المعلمين و التطوير التربوي الذين حصلت عليهما.
الرجاء الإجابة على جميع الأسئلة مع التنبيه أنه إذا كنت غير متأكد من الإجابة أو لديك إجابة محايدة فيمكنك دائماً اختيار إجابة (لا أوافق أو أخالف).

**المصطلحات**:
**الرياضيات** : تعني محتوى مادة الرياضيات.
**طرق تعليم الرياضيات**: تعني طرق تدريس الرياضيات.
**التقنية**: تعني كيفية استخدام التقنية.
**تقنيات التعليم**: تعني كيفية استخدام التقنية في التعليم.

١ـ كم عدد المواد الدراسية التي أكملتها في كل من الفروع التالية؟

الرياضيات ______
طرق تعليم الرياضيات ________
تقنيات التعليم ______
التقنية ( مثل، الحاسب الآلي، البرمجة، ....الخ) ______

٢ـ المواد الدراسية التي أكملتها في هذه الفروع أعدتني لدمج التقنية الرقمية في تدريسى بشكل فعال:

| الفرع الدراسي | لا أوافق بشدة (١) | لا أوافق (٢) | لا أوافق أو أخالف (٣) | أوافق (٤) | أوافق بشدة (٥) |
|---|---|---|---|---|---|
| الرياضيات | | | | | |
| طرق تعليم الرياضيات | | | | | |
| تقنيات التعليم | | | | | |
| التقنية | | | | | |

٣- باستخدام مقياس الدرجات التالي : ممتاز مرتفع (A+)، ممتاز (A)، ممتاز منخفض (A-)، جيدجداً مرتفع (B+) ، جيدجداً (B)، جيدجداً منخفض (B-)، جيد مرتفع (C+)، جيد (C)، جيد منخفض (C-)، مقبول مرتفع (D+)، مقبول(D)، مقبول منخفض (D-)، راسب (F).

قم بتقدير متوسط درجاتك في مواد الرياضيات: __________
و تقدير متوسط درجاتك في مواد التقنية: ____________
و تقدير متوسط درجاتك في مواد طرق تعليم الرياضيات: _________
و تقدير متوسط درجاتك في مواد تقنيات التعليم: ______________

٤- كم عدد ساعات التدريب أو التطوير التربوي (مثل: الورش والدورات التعليمية) التي حضرتها خلال هذه السنة التعليمية في المجالات التالية؟
الرياضيات _______ طرق تعليم الرياضيات _________
تقنيات التعليم _______ التقنية ( مثل، الحاسب الآلي، البرمجة، ....الخ) _______
أخرى _______ ( الرجاء تسميتها) _________________________________

٥- قامت برامج و دورات التدريب أو التطوير التربوي التي أكملتها في هذه المجالات بإعدادي لاستخدام التقنية الرقمية في تدريسي بشكل فعال:

| المجال التربوي | لا أوافق بشدة (١) | لا أوافق (٢) | لا أوافق أو أخالف (٣) | أوافق (٤) | أوافق بشدة (٥) |
|---|---|---|---|---|---|
| الرياضيات | | | | | |
| طرق تعليم الرياضيات | | | | | |
| تقنيات التعليم | | | | | |
| التقنية | | | | | |

**الجزء الثالث**: هذا الجزء سوف يقيس مستوى القلق لديك عند تدريس الرياضيات و استخدام التقنية خلال التدريس. الرجاء الإجابة على جميع الأسئلة مع التنبيه أنه إذا كنت غير متأكد من الإجابة أو لديك إجابة محايدة فيمكنك دائماً اختيار إجابة (لا أوافق أو أخالف).

| | لا أوافق بشدة (١) | لا أوافق (٢) | لا أوافق أو أخالف (٣) | أوافق (٤) | أوافق بشدة (٥) |
|---|---|---|---|---|---|
| أنا أشعر بالقلق عند تدريس الرياضيات. | | | | | |
| أنا أشعر بالقلق عند استخدام التقنية في التدريس. | | | | | |

**الجزء الرابع**: الغرض من هذا الجزء من الاستبانة هو الحصول على بعض بياناتك الشخصية. خلال الإحدى عشرة فقرة التالية، الرجاء اختيار أو إعطاء الإجابة التي تصف بياناتك الشخصية بشكل أفضل.

**البيانات الشخصية:**

١- ما هي المراحل الدراسية التي تدرسها هذه السنة؟ ________________

٢- كم هو متوسط عدد التلاميذ في كل صف من هذه الصفوف؟ _________

٣- ما عدد سنوات خبرتُك في التدريس؟ (إذا كانت هذه هي سنتك الأولى في التدريس، فالرجاء وضع الرقم صفر) ____

٤- كم عدد سنوات تدريسك للرياضيات؟ ______

٥- كم عدد سنوات تدريسك لمواد غير الرياضيات؟ _____

٦- ما هو مستواك التعليمي؟

أ. أقل من بكالوريوس
ب. بكالوريوس
ج. ماجستير
د. دكتوراه

٧- ما هو تخصصك؟

أ. رياضيات
ب. تعليم رياضيات
ج. تعليم إبتدائي
د. تعليم ثانوي (مسارات)
هـ. آخر (الرجاء التحديد) ____________________

٨- ما هي الجامعة أوالكلية التي تخرجت منها؟

أ. كلية المعلمين بالرياض
ب. جامعة الملك سعود
ج. جامعة الإمام محمد بن سعود الإسلامية
د. آخرى (الرجاء التحديد) __________

٩- ماذا كانت درجتك في اختبار المعلمين الذي يقيمه المركز الوطني للقياس و التقويم في التعليم العالي (قياس)؟

في الجزء التربوي: ________
في الجزء اللغوي: _________
في الجزء العددي: _________
في جزء التخصص: ________
في الدرجة الكلية: _________

١٠- عُمرك؟ _______

١١- ما هو عنوان بريدك الإلكتروني (إذا لم يكن لديك بريد الكتروني, يرجي كتابة غير متاح).

___________@___________

شكراً ،

خطاب مدير المدرسة

عزيزي مدير المدرسة

السلام عليكم و رحمة الله و بركاته ، فنحن بحاجة لمساعدتك في دراسة تبحث مدى تأثير التطوير التربوي في الارتقاء بمستوى فاعلية المعلمين التدريسية. حيث نرجو أن يقوم معلمو الرياضيات بمدرستكم بتقييم مستواهم المعرفي في كل من المحتوى الدراسي، وطرق التدريس، واستخدام تقنيات التعليم، ثم بعد ذلك تقومون أنتم بتقييم فاعليتهم التدريسية.

هناك أربعة عشر مجالاً تشمل قدرات تعليمية مختلفة، ونريد التأكيد على أن كل البيانات المعطاة سوف تكون سرية بما يحفظ خصوصية المعلم والمدرسة. والشخص الوحيد الذي سوف يطلع على أسماء المعلمين هو أنتم فقط ، ولن يصل للباحث إلا بيانات إحصائية مبهمة و التي لن يطلع عليها أيضاً المعلمين.

وسوف تجدون برفقه قائمة بيانات فارغة واحدة، و استبانات لفاعلية المعلمين التدريسية، و استبانات للمعلمين.

أولاً: سوف تقومون بوضع رقم استبانة المعلم قبل توزيعها إلى جانب اسم المعلم في قائمة البيانات و التي سوف تحتفظون بها.

ثانياً: سوف تقومون بملء استبانة فاعلية المعلمين التدريسية لكل معلم رياضيات في مدرستكم.

ثالثاً: يتم ارسال كل من: ١) استبانات المعلمين بعد تعبئتها من قبل كل معلم رياضيات في مدرستكم ، ٢) استبانات فاعلية المعلمين التدريسية.

و لكم كل الشكر و التقدير على الجهد و الوقت الذي سوف تبذولونه لتوفير هذه البيانات، و إذا كان لديكم أي سؤال أو استفسار أو تعليق فنأمل التواصل معنا.

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Approved by the Human Subjects Committee University of Kansas, Lawrence Campus (HSCL) on 12/28/2011. Approval expires one year from 7/13/2011. HSCL# 19515

## قائمة بيانات

| م | اسم المعلم | رقم استبانة المعلم |
|---|---|---|
| ١ | | |
| ٢ | | |
| ٣ | | |
| ٤ | | |
| ٥ | | |
| ٦ | | |
| ٧ | | |
| ٨ | | |
| ٩ | | |
| ١٠ | | |

ملاحظة: هذه القائمة هي فقط لمساعدتكم في ربط أسماء المعلمين بأرقام استباناتهم و استخدامها عند تعبئة استبانات فاعلية المعلمين التدريسة المرفقة ، لذا يرجى إتلافها بعد الانتهاء من ملء الاستبانات.

**Approved by the Human Subjects Committee University of Kansas, Lawrence Campus (HSCL) on 12/28/2011. Approval expires one year from 7/13/2011. HSCL# 19515**

## استبانة فاعلية المعلمين التدريسية

**رقم استبانة المعلم :**

**تعليمات :** يرجى وضع رقم استبانة المعلم أولاً، ثم تقييم فاعلية معلم الرياضيات في كل واحدة من القدرات التدريسية الأربع عشرة.

**السؤال :** ما هو مستوى فاعلية قدرات هذا المعلم التدريسية مقارنةً بمن عملت معهم من معلمي الرياضيات الآخرين في كل مجال من المجالات التالية :

| م | المجال | من أقل ٢٠٪ | من أقل ٥٠٪ | من أعلى ٥٠٪ | من أعلى ٢٥٪ | من أعلى ١٠٪ |
|---|---|---|---|---|---|---|
| ١ | طرق التدريس | | | | | |
| ٢ | الإلمام بمحتوى المادة | | | | | |
| ٣ | فاعلية استخدام تقنيات التعليم | | | | | |
| ٤ | روح المبادرة | | | | | |
| ٥ | الإبداع | | | | | |
| ٦ | الحماسة في التدريس | | | | | |
| ٧ | التعاون مع المشرفين التربويين | | | | | |
| ٨ | التعاون مع زملائه المعلمين | | | | | |
| ٩ | العلاقة مع أولياء الأمور | | | | | |
| ١٠ | العلاقة مع طلابه | | | | | |
| ١١ | إعداد الصف (مثل: تحضير الدروس، توزيع الطلاب في الصف، توفير مصادر التعلم ...الخ) | | | | | |
| ١٢ | حفظ النظام | | | | | |
| ١٣ | الرغبة في تطوير الذات في مجال التخصص | | | | | |
| ١٤ | النجاح في التدريس بشكل عام | | | | | |

# Appendix O
# TPACK Scale's Permission

From: Lisa Hervey <[redacted]>
Subject: **Re: TPACK Survey for mathematics teachers**
Date: May 24, 2011 5:53:30 PM CDT
To: khaled Alshehri <[redacted]>

Khaled,
Sorry I have been slammed! You have my permission to use my adapted version of Survey of Preservice Teachers' Knowledge of Teaching and Technology (Schmidt et al., 2009) with the understanding that serious work to establish validity and reliability are still called for.

On Mon, May 23, 2011 at 9:17 PM, khaled Alshehri <[redacted]> wrote:

> Hello Dr. Hervey,
>
> I do not know if you have received my previous email but I was asking you if I could use your research instrument to measure secondary math teachers' TPACK. The target population for my study is secondary and high school math teachers and I probably is going to need to make some changes to it.
>
> Thank you,
>
> Khaled Alshehri
>
> On May 11, 2011, at 5:42 PM, Khaled Alshehri wrote:
>
> > Dear Dr. Hervey,
> >
> > My name is Khaled Alshehri, I am a graduate student at the university of Kansas and I'm doing my doctoral research about "in-service mathematics teachers' TPACK level and its effectiveness on students achievement". I have read your dissertation that your recently completed, so congratulations. And I would like to ask you if I could adapt the mathematical part of your TPACK scale in my doctoral research to do the self-evaluation for my research participants.
> >
> > Sincerely,
> >
> > Khaled Alshehri

Good luck on your research!
-Lisa

Lisa Hervey, Ph.D., NBCT
Research Associate
The Friday Institute
North Carolina State University
AIM/SKYPE/TWITTER: [redacted]

Some teachers believe their job is done when they are done teaching; I believe my job is done when the students have learned. -Richard DuFour

Appendix P
Teacher Effectiveness Survey's Permission

From: Annick Brennen <[redacted]>
Subject: **Re: Applicant Reference Record survey**
Date: May 24, 2011 6:43:15 AM CDT
To: khaled Alshehri <[redacted]>

Please feel free to do so.

On Tue, May 24, 2011 at 2:26 AM, khaled Alshehri <alborasain@gmail.com> wrote:

> Dear Mrs. Brennen,
> I would like to ask you for a permission to use and modify your Applicant Reference Record survey (Recruitment and Selection) for my doctoral research. I am going to use it for principal evaluation of mathematics teachers in secondary and high schools.
> Sincerely,
> Khaled Alshehri

--
Annick M. Brennen, M.A.
327-1980
Nassau, The Bahamas